The Blast Furnace and Steel Plant

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The Blast Furnace and Steel Plant

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National Basic Research

THE value of basic research, aimed at the acquisition of knowledge without immediate utilitarian objectives, was emphasized in the report of the Visiting Committee of the Bureau of Standards. The committee expressed the belief that such work should be undertaken by the Bureau to a greater extent than has been done in recent years.

"The history of civilization is filled with illustrations of the utilization for the good of humanity of the results of scientific work, undertaken without reference to its direct value and often remaining unused long after its first announcement," the report states. Illustrations given are the electrical industry, radio, the vacuum tube, X-rays, and radium. In each case the fundamental discoveries that made invention possible were made without thought of possible utility. Similarly, the present day study of atomic physics is cited as a line of research that is likely in the future to yield results of vast proportions, and as yet undreamed of.

The report also calls attention to the value of industrial research—a value more generally realized. Numerous examples of savings effected by such research at the Bureau of Standards are given. Studies of certain problems pertaining to the automobile industry are cited, whose combined result is a saving of $155,000,000 per year to the American public.

Both types of research, the committee believes, are essential to the welfare and industrial prosperity of the nation. The economies resulting from them are often very considerable, and are necessary if America is to maintain its present high wage rates and high standards of living in the era of intense industrial competition upon which the world now appears to be entering.

The desirability of having research conducted by a national institution is emphasized. Its value depends on the extent to which the results are utilized rather than upon the cost of the work, and a national laboratory such as the Bureau of Standards can afford to give its results freely to all who can profit by them, whereas a private laboratory cannot always be expected to do so.

Material and Heat Balance of a Southern Foundry Furnace*

By S. P. KINNEY†

DURING an investigation that included observations on temperatures, pressures, and gas sampling across a series of planes between the tuyere level and the stock line of a Southern foundry furnace owned by the Central Iron & Coal Company at Holt, Alabama, it was found desirable to make a material and heat balance, which is reported herein.

An attempt was made to obtain accurate samples and analyses of all materials entering and leaving the furnace. The analyses were made by the company and at the Pittsburgh Experiment Station of the Bureau of Mines. Weights of materials charged and discharged were taken from the company records. As operation of industrial furnaces is not conducted with such detailed accuracy as is indicated by the furnace balance sheet, it was necessary to make numerous special observations to obtain values not shown by company records, and in a few cases certain assumptions were made.

From the results of the balance sheet a heat balance has been constructed. This has been developed after the method of Mathesius‡. The method has also been used by Royster, Joseph, and Kinney in determining the heat balance of the Bureau of Mines experimental furnace at Minneapolis, and of 14 other American blast furnaces§.

Results of Investigation.

The results of the investigation are reported in Tables I, II, III, IV, and V. In Table I the average analyses of a good many samples of the raw materials charged have been set down; the analyses are given for material as charged, moisture included. Separate moisture determinations were made on large samples. In Table II the components of the charge are set down in pounds per long ton of metal produced. The percentage of each component of the charge is shown, both vertically and horizontally. In Table III the materials discharged in pounds per long ton of metal are shown. Table IV gives analyses of samples of materials discharged. Table V indicates the calculated analysis of materials discharged, which has been constructed from Tables II and III, and is given as a comparison and check for the results by actual analyses shown in Table IV. In Table V the analyses of gas are given by weight and volume.

Heat Balance.

The development of the heat balance has been made from the results of the material balance shown in Tables I to V. Details of the calculations follow, and the results have been brought together in Table VII where they are compared with four northern furnaces and the averages obtained by Royster, Joseph, and Kinney for 14 northern furnaces. In Table VI are given the operating data for the furnaces compared.

Details of Heat Production and Consumption—Heat Produced.

From the balance sheet of materials charged and discharged it may be shown that the gases contain the amount of carbon per long ton of metal produced given below. Using thermal constants after Mathesius, the CO and CO_2 generated 4,446 and 14,543 Btu. per pound of carbon.

	Btu.	Per Cent
Heat produced by combustion of carbon (pounds of carbon × thermal constant):		
Pounds of C as CO, 1,658.07 × 4,446 =	7,371,759	51.0
Pounds of C as CO_2, 329 × 14,543.... =	4,784,637	33.1
Heat brought in by air (wt. of dry air × sq. heat × blast temp., °F.): 9,627.88 × 0.248 × 957............... =	2,284,692	15.9
Heat brought in by moisture in air (wt. of water × specific heat of steam × blast temperature, °F.): 67.92 × 0.49 × 957.................. =	31,847	
Total heat produced per long ton of metal, Btu.	14,472,935	100.0

Heat Accounted For.

Heat required for reduction:

Each ton of iron contained 2,084.25 pounds of Fe, of this 328.98 came from scrap, 480.2 from Fe_3O_4, and 1,274.97 from Fe_2O_3; 2,870 Btu. are absorbed for each pound of iron reduced from Fe_3O_4 and 3,240 from Fe_2O_3.

		Btu.	Per Cent
480.2 × 2,970 .... =	1,426,194		
1,274.97 × 3,240......... =	4,130,892		
	=	5,557,086	38.4
Reduction of Si, Mn, and P (pounds × thermal constant):			
Si 45.02 × 14,090 Btu. per lb. =	634,331		
Mn 16.17 × 2,970 Btu. per lb. =	48,025		
P 13.51 × 10,620 Btu. per lb. =	143,476		
	=	825,832	5.7
Decomposition of carbonates:			
1,830 Btu. are absorbed per lb. of CO_2 from $CaCO_3$			
1,198 Btu. are absorbed per lb. of CO_2 from $MgCO_3$			
CO_2 from $CaCO_3$ 447.6 lb. × 1,830.......... =	819,108		
CO_2 from $MgCO_3$ 298.3 lb. × 1,198.......... =	357,362		
	=	1,176,470	8.1
Decomposition of water:			
Top gas indicates the presence of 19.88 pounds of H_2, which was produced by the decomposition of 178.9 pounds of water; this required 5,760 Btu. per pound. 178.9 × 5,760........................	=	1,030,464	7.2
Heat carried off by metal:			
Average metal temperature 2,525 °F. (1,385 °C.), which indicates that the metal carried off 485 Btu. per pound. 2,240 × 485	=	1,096,400	7.5

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‡Mathesius, W., High Blast Heats in Mesabi Practice. Trans. American Institute Min. & Met. Engrs., vol. 51, 1915, pp. 794-810.

§Royster, P. H., Joseph, T. L., and Kinney, S. P., Heat Balance of Bureau of Mines Experimental Blast Furnace. *The Blast Furnace and Steel Plant*, vol. 6, April, 1924, pp. 200-204.

Heat carried off by slag:

Average slag temperature 2,568 °F. (1,385 °C.), which indicates that the slag carried off 840 Btu. per pound.

1,786.47 × 840 .... = 1,500,632 10.4

Heat carried off by gases:

Sensible heat of top gases = wt. of gas × top temperature × sp. heat.

CO_2 1,952.3 × 335 × 0.2169 = 141,854
CO 3,868.85 × 335 × 0.2426 = 314,421
H_2 19.88 × 335 × 3.4090 = 22,702
N_2 7,403,86 × 335 × 0.2438 = 604,673

= 1,083,650 7.5

Heat carried off by moisture in gases:

The moisture in the charge entered as liquid at 70°F. and was raised to 212° (142 Btu. per lb.), evaporated at 212° (964.8 Btu. latent heat) and superheated to 335° = 123° (0.48 × 123 = 59 Btu. per lb. superheat. Total heat carried away is therefore (142 + 964.8 + 59) = 1,165.8 Btu. per lb. The charge contained 559.12 pounds of water per long ton of metal.

1,165.8 × 559.12 .... = 651.819 4.5

Total heat accounted for........ = 12,912,353 Btu. 89.3 Per Cent

Discussion of Results.

Little discussion is needed of the results of the material balance. However, it might be pointed out that during the 10-day test it so happened that the materials used were somewhat better than the average. The proportion of brown ore consumed was higher and the red ore was lower. This condition gave a burden that was probably slightly richer than usual. This in turn gave a smaller resultant slag volume. However, the results serve to illustrate practice at one southern furnace.

In Table VI is a comparison of the results obtained at Holt with those obtained at four northern furnaces and the average results obtained at 14 northern furnaces. The results for the 4 furnaces have been picked at random from the detailed results of the 14 furnaces. These have been arranged according to coke consumption. From Table VI it will be seen that the Holt furnace is smaller than the 14 furnaces, but this has little or no effect on the comparison. In comparing the data from the 4 furnaces and the average results from the 14 furnaces it will be noted that the blast, top, metal, tuyere, and slag temperatures are lower in the Holt furnace. In each case the ore burden is approximately the same, the coke consumption is higher, so is the limestone except in one case. The slag volume in the Holt furnace is 132 per cent to 223 per cent of the 4 furnaces, and has a volume of 171 per cent of the average of the 14 furnaces. The iron content of the ore is lower.

As the southern ores contain lime and the northern ores do not, a comparison of the two burdens should contain the limestone in the charge. In Table VIII is a comparison of ore burdens in northern and southern furnaces.

Table VIII shows in each case that the iron ore plus the limestone contains less iron in the southern furnace than in the northern furnaces. No. 2 furnace is approximately the same. This accounts for the large slag volume, which in turn probably causes the lower metal, slag, and tuyere temperatures. There is a marked difference in the gases from the two practices; the carbon dioxide is lower and the carbon monoxide is higher in the southern furnace, which denotes a lower fuel economy.

Comparison of the heat balances for the same furnaces in Table VII show that the low CO_2 and the high CO in the gases changes the aspect of the items under "Heat produced". The total heat generated per ton of iron produced is less in the Holt furnace in three cases, and greater in one, than the heat generated in the four northern furnaces, and less than the average of 14 furnaces shown. If the percentage items for Holt under the head of "Heat consumed" be compared with the same values given for the 14 northern furnaces it will be noted that practically twice as much heat is expended in calcining the carbonates in the Holt furnace as in the northern furnaces. This condition is caused by the higher lime consumption in southern practice, due to the higher slag volume dealt with. Of the heat generated in the southern furnace, 10.4 per cent is carried off with the slag, while approximately 6 per cent is taken off in the northern furnaces. This again is due to the large slag volume. Of the heat produced in the southern furnace 7.5 per cent is carried off by the gases, while 4.1 per cent is carried off in the northern furnaces. This is accounted for by the larger gas volume which is due to larger fuel consumption.

TABLE 1. - Analyses of raw materials, per cent.

Constituent	Brown ore	Attalla red ore	Estelle red ore	Nodules	Limestone	Coke
H_2O	13.98	1.30	3.88	9.45	0.10	5.40
SiO_2	14.10	10.05	7.74	10.80	1.00	6.76
Al_2O_3	5.70	3.20	4.83	4.20	0.60	4.10
Fe_2O_3	61.70	56.10	43.25	53.09	1.00	1.21
FeO	0.00	0.00	0.00	20.61	0.00	0.00
MnO	1.02	0.18	0.14	0.08	0.03	0.00
P_2O_5	1.56	0.42	0.21	0.07	0.01	0.04
CaO	0.22	14.80	20.91	0.60	30.22	0.27
MgO	0.22	0.30	0.90	0.10	21.21	0.16
K_2O	0.30	0.80	0.60	0.30	0.00	0.17
Na_2O	0.30	0.30	0.50	0.20	0.00	0.06
S	0.10	0.00	0.10	0.30	0.10	1.02
CO_2.	0.80	12.10	16.93	0.20	45.73	0.00
Fixed carbon	-	-	-	-	-	80.35
Volatile matter	-	-	-	-	-	0.46
	100.00	100.00	100.00	100.00	100.00	100.00

In 14 northern furnaces the average results show that 34 per cent of the heat was produced by oxidation of C to CO and 52 per cent by oxidation of C to CO_2. In the southern furnace there is a marked difference, the condition is reversed; 51 per cent of the heat produced came from oxidation of C to CO and 33 per cent from oxidation of C to CO_2. This condition of course indicates the lower fuel economy.

In considering the heat balances shown, the following figures may be set down: In the northern furnace approximately 15,000,000 Btu. are produced per long ton of metal made, 5,000,000 by oxidation of C to CO and 8,000,000 by oxidation of C to CO_2. Of this approximately 6,500,000 Btu. are used in the reduction of the iron oxides and approximately 500,000 for the reduction of MnO, P_2O_5, and SiO_2. These last two values are practically constant for all furnaces, north and south, and vary only slightly in accordance with the amount of scrap and Fe_3O_4 in the burden and the amount of Si, Mn, and P entering the metal. All other items of the heat balance, under the head "Heat consumed", are necessary to the process but might be considered necessary evils — in other words, losses. They do not actually concern the reduction of iron oxides. In general, these so-called losses tend to be higher in the southern than in the northern furnaces.

Suggestions for Improving Blast-Furnace Process.

In considering the possibilities of improving the blast-furnace process we have several openings, such as (1) produce top gases with a higher CO_2 content and a lower temperature; and (2) reduce the heat losses shown under items 3 to 8 of Table VII.

In regard to the first item, Table VI might be examined. It shows that the average top gas analyses for 14 furnaces contain 12.9 per cent CO_2, with a top temperature of 335 deg. F. Better average values than these can be obtained and are being obtained at some plants. There is room for improvement here, but there is a limit to the extent to which the CO_2 may be increased. In considering item (2) it might be pointed out that in northern furnaces 42.2 per cent of the heat is used in reduction of the metal oxides, 39.0 per cent is consumed by calcination, dissociation of moisture, absorption by the iron, slag, gases, and by the moisture in the gases, and 18 per cent is unaccounted for. In other words, the actual work of producing a ton of metal has effectively used about 52 per cent of the heat produced. The ideal condition would be one where 100 per cent of the heat produced

TABLE 2. - Materials charged, pounds per long ton of metal produced.

Constituent	Scrap	Brown ore	Atalla ore	Estelle ore	Nodules	Stone	Coke	Air	Total	Per cent
H_2O	-	296.01	8.52	16.98	94.74	1.22	141.65	67.92	627.04	3.47
SiO_2	-	298.99	68.68	33.85	108.05	12.51	177.76	-	699.84	3.86
Al_2O_3	-	121.23	20.85	21.09	42.00	7.54	107.68	-	320.39	1.77
Fe	328.98	910.72	255.97	131.90	531.48	8.71	22.20	-	2189.96	12.09
O_2	-	395.65	110.56	57.70	206.10	3.80	9.57	2224.02	3007.38	16.62
CaO	-	4.66	96.58	91.61	6.01	379.47	7.05	-	585.38	3.23
MgO	-	4.23	1.96	3.92	0.98	264.29	4.23	-	279.61	1.54
P_2O_5	-	33.03	2.70	0.92	0.74	0.12	1.10	-	38.61	0.21
MnO	-	21.58	1.23	0.61	0.80	0.37	0.00	-	24.59	0.14
K_2O	-	6.35	0.54	2.61	3.03	0.00	4.59	-	17.12	0.09
Na_2O	-	6.34	0.20	2.23	2.00	0.00	1.48	-	12.25	0.05
S	-	2.15	0.00	0.43	3.00	1.22	26.80	-	33.60	0.19
CO_2	-	16.92	79.10	74.07	2.02	573.86	0.00	-	745.97	4.12
C	-	-	-	-	-	-	2110.66	-	2110.66	11.65
H_2	-	-	-	-	-	-	12.08	-	12.08	0.06
N_2	-	-	-	-	-	-	-	7403.86	7403.86	40.89
Total	328.98	2117.84	646.89	437.92	1000.95	1253.11	2626.85	9695.80	18108.34	-
Per cent	1.82	11.69	3.57	2.43	5.53	6.92	14.50	53.54	-	100.00

Table 3.- Materials discharged, pounds per long ton of metal produced.

Constituent	Flue Dust	Metal	Slag	Gas	Water	Total	Per cent
H20	---	---	---	---	559.12	559.12	3.09
SiO2	34.48	---	569.26	---	---	603.74	3.33
Al2O3	18.70	---	301.69	---	---	320.39	1.77
Fe	92.47	2084.25	13.24	---	---	2189.96	12.10
O2	39.67	---	1.89	---	---	41.56	0.23
CaO	13.67	---	571.71	---	---	585.38	3.23
MgO	4.17	---	275.44	---	---	279.61	1.54
P2O5	0.92	---	6.79	---	---	7.71	0.04
MnO	1.29	---	2.44	---	---	3.73	0.02
K20	5.62	---	11.50	---	---	20.83	0.11
Na20	4.19	---	8.06	---	---	8.54	0.05
S	8.16	0.99	24.45	---	---	33.60	0.19
CO2	13.37	---	---	1252.30	---	1965.67	10.86
C	40.35	80.06	---	---	---	120.41	0.66
Si	---	45.02	---	---	---	45.02	0.25
Mn	---	16.17	---	---	---	16.17	0.09
P	---	13.51	---	---	---	13.51	0.076
H2	---	---	---	19.88	---	19.88	0.11
N2	---	---	---	7403.86	---	7403.86	40.89
CO	---	---	---	3868.85	---	3868.85	21.37
Volatile Matter	0.80	---	---	---	---	0.80	0.004
Total	277.86	2240.00	1786.47	13244.89	559.12	18108.34	---
Per cent	1.53	12.37	9.86	73.15	3.09	---	100.00

is used in reducing the oxide. The 42 per cent of heat produced will vary with the iron content of the burden, and in turn with that of the ore. As the iron content of the ore decreases the silica increases, and more flux and coke are required to carry on the process. The 42 per cent of the heat produced consequently diminishes. This is the condition in southern furnaces — the iron content of the burden is lower, which necessitates the use of more flux and fuel.

TABLE 4. – Materials discharged, by actual analysis, per cent.

Constituent	Flue dust	Metal	Slag	Gas, per cent by volume
SiO_2	12.9	—	32.15	--
Al_2O_3	7.1	—	16.23	--
Fe	34.2	93.021	0.28[c]	--
O_2	14.8	—	0.13	--
CaO	5.2	—	32.29	--
MgO	1.6	—	15.88	--
P_2O_5	0.35	—	0.33	--
MnO	0.49	—	0.21	—
K_2O	1.20[a]	—	0.64	—
Na_2O	1.43[a]	—	0.45	--
S	0.30[b]	0.044	1.41	--
CO_2	5.06	—	--	9.78
C	15.07	3.60	--	--
Si	—	2.01	--	--
Mn	—	0.722	--	--
P	—	0.603	--	--
H_2	0.30	—	—	2.17
N_2	—	—	—	58.01
CO	—	—	—	30.04
Volatile matter	—	—	—	—
Total	100.00	100.00	100.00	100.00

[a] 2.29 pounds of K_2O and 0.23 pounds of Na_2O carried to stoves and boilers; actual analysis of flue dust therefore lower than calculated analysis.

[b] Approximately 25 per cent of sulfur charged was volatilized, therefore not shown in actual analysis.

[c] Analysis of slag made after removal of iron shot. Including shot, the slag contained 0.74 per cent Fe, 0.46 per cent of this in the metallic form in shot, which is equal to approximately 82 pounds of iron per ton of metal.

TABLE 5. – Materials discharged, calculated analysis, per cent.

Constituent	Flue dust	Metal[a]	Slag	Gas, per cent by weight	Gas, per cent by volume
SiO_2	12.41	-	31.86	-	-
Al_2O_3	6.72	-	16.88	-	-
Fe	33.30	93.021	0.74	-	-
O_2	14.30	-	0.11	-	-
CaO	4.93	-	32.01	-	-
MgO	1.50	-	15.42	-	-
P_2O_5	0.33	-	0.38	-	-
MnO	0.45	-	0.14	-	-
K_2O	2.02	-	0.64	-	-
Na_2O	1.51	-	0.45	-	-
S	2.94	0.044	1.37	-	-
CO_2	4.81	-	-	14.75	9.73
C	14.49	3.60	-	-	-
Si	-	2.01	-	-	-
Mn	-	0.722	-	-	-
P	-	0.603	-	-	-
H_2	-	-	-	0.15	2.16
N_2	-	-	-	56.00	57.90
CO	-	-	-	29.15	30.30
Volatile matter	0.29	-	-	-	-
Total	100.00	100.00	100.00	100.00	100.00

[a] Actual analysis.

Examination of the items in Table VII for the Holt furnace shows that 38.8 per cent of the heat produced was used in the reduction of oxides, 50.9 per cent was consumed by items 3 to 8, and 10 per cent was not accounted for. Here it is shown that these so-called heat losses have increased in southern practice over northern practice from 39 to 50 per cent, this by a lowering of the iron content in the burden and the necessary increase in coke consumption. The values compared are with only one southern furnace, but the increase in heat consumption over and above that actually used in the reduction of the oxides is clearly shown. It would be very desirable to have data for calculating heat balances for a series of representative southern furnaces.

Table 6.– Operating data from 4 northern furnaces compared with operating data at Holt and with the average of 14 northern furnaces

Item	Furnace	Average of 4 furnaces 1	2	3	4	Holt furnace	Average of 14 furnaces
	Dimensions:						
1	Height; ft.	92.5	90	88	85	85	86.9
2	Bosh dia.; ft.	22	22	21.5	21	19.5	21.9
3	Hearth dia.; ft.	16.6	17	17.3	16	14.5	16.8
4	Bosh angle, degrees	77°	—	80°	78.6°	79	78.6°
	Temperatures:						
5	Blast °F.	1106	825	1100	1150	957	1012
6	Top °F.	325	425	377	475	336	337
7	Tuyere °C.	1821	1730	1703	1648	1534	1714
8	Slag °C.	1528	1481	1544	1473	1409	1501
9	Metal °C.	1459	1457	1484	1444	1386	1488
	Charge, lb. per ton:						
10	Ore	3204	4436	4218	4474	4200	3970
11	Coke	1704	2000	2158	2480	2627	2000
12	Stone	723	898	839	1267	1253	906
	Scrap	-	-	-	-	329	-
13	Slag	800	1222	1020	1366	1786	1046
	Analyses of charge; per cent:						
14	Fe in ore	55.9	49.9	50.9	53.4	43.2	51.9
15	$SiO_2+Al_2O_3$ in ore	7.4	10.3	10.6	10.2	20.8	9.3
16	S in coke	0.82	0.61	0.76	1.18	1.02	0.90
17	Ash in coke	11.0	10.7	10.3	13.0	13.79	11.6
18	F.C. in coke	88.14	88.90	84.89	85.31	—	86.46
	Analysis of metal; per cent:						
19	Si	1.59	1.12	1.43	1.51	2.01	1.32
20	S	0.032	0.033	0.038	0.036	0.044	0.037
21	Mn	0.80	1.84	1.05	0.68	0.72	1.06
22	P	0.085	0.324	0.250	0.100	0.60	0.156
	Analysis of slag; per cent:						
23	SiO_2	36.0	35.8	36.0	34.9	32.15	34.8
24	Al_2O_3	15.5	12.4	13.3	13.1	16.23	14.7
25	CaO	38.9	44.5	45.6	48.5	32.29	43.5
26	MgO	7.3	5.7	4.8	2.0	15.88	4.45
27	S	1.70	1.29	1.33	1.62	1.41	1.57
28	MnO	—	—	0.56	—	0.21	0.89
29	FeO	—	0.65	0.33	0.96	0.41	0.68
	Analysis of gas; per cent by volume:						
30	CO_2	13.2	12.8	12.2	12.5	9.73	12.9
31	CO	26.4	24.4	27.0	25.9	30.30	26.0
32	H_2	3.8	2.3	3.0	1.4	2.16	2.9
33	N_2	56.6	60.5	57.8	60.2	57.90	58.3
	Analysis of gas; per cent by weight:						
34	CO_2	19.9	19.1	18.4	18.5	14.75	19.3
35	CO	25.4	23.2	25.9	24.5	29.15	25.0
36	H_2	0.21	0.16	0.21	0.09	0.15	0.20
37	N_2	54.4	57.5	55.5	56.9	56.0	55.5
38	**Production: tons pig iron per day:**	544	562	477	567	324.7	540

When the heat required to reduce enough oxide to form a ton of metal has decreased to a point where it is equal to say 30 per cent of the total heat required in the process, we will find that we are working with low-grade ores requiring large quantities of flux and fuel. At this point it will be necessary to turn to some other more economical means of operation than present methods. We will then have reason to consider one of the many so-called direct processes which have been proposed, where the oxide would be reduced or partly reduced, without the formation of slag, and later separated from the gangue material by means of gravity or magnetic concentration.

Table 7.- Distribution of heat in 4 northern furnaces compared with the distribution at Holt and with the average of 14 furnaces.

Heat produced:	Four furnaces				Holt	Per cent	Average of 14 furnaces	
							Average	Per cent
1. Combustion C to CO	4,435,380	5,321,980	5,960,190	6,460,410	7,371,759	51.0	5,209,980	34.12
2. Combustion C to CO_2	6,831,880	8,446,950	8,294,860	9,440,093	4,784,637	33.1	7,969,300	52.19
3. Heat in blast (including moisture)	1,803,840	2,419,520	2,414,240	2,961,880	2,316,539	15.9	2,091,500	13.69
Total heat	13,071,100	16,188,500	16,669,300	18,862,400	14,472,935	100.0	15,270,800	100.00
Heat consumed:								
1. Reduction of iron oxides	4,041,080	7,167,870	6,956,160	7,740,740	5,551,086 ~~[illegible]~~	38.4	6,553,900	42.92
2. Reduction of MnO, P_2O_5, and SiO_2	575,270	554,830	579,330	545,610	825,832	5.7	525,100	3.44
3. Calcination of carbonates	562,150	920,080	734,970	1,005,960	1,176,470	8.1	692,700	4.53
4. Dissociation of moisture	990,680	975,770	1,305,390	640,290	1,030,464	7.2	1,115,588	7.30
5. Carried off with the iron	1,143,180	1,125,950	1,162,770	1,131,430	1,086,400	7.5	1,143,100	7.50
6. Carried off with the slag	731,120	1,087,080	942,450	1,206,470	1,500,632	10.4	928,700	6.08
7. Carried off with gases (dry)	728,490	1,244,910	1,116,170	1,581,370	1,083,650	7.5	923,810	6.05
8. Carried off with moisture in top gas	532,900	695,120	600,120	776,790	651,819	4.5	634,200	4.15
Total heat accounted for.	9,304,900	13,771,600	13,397,400	14,628,700	12,912,353	89.3	12,517,200	81.97
Heat unaccounted for	3,766,200	2,416,900	3,271,900	4,233,700	1,560,582	10.7	2,753,600	18.03
Heat unaccounted for per cent	28.8	14.9	19.6	22.4	-	—	-	-

Such a process might be carried on by the use of a slagging-type gas producer, similar in shape to the bosh and hearth of the present-day blast furnace. Gases from the producer at a temperature of 800 to 900 deg. C. and of the composition of those found in the bosh of the blast furnace (32 to 34 per cent CO), might be used to reduce the oxides which had been placed in a column similar in shape to that of the upper part of the blast furnace. The metal dispersed in the gangue material would then be discharged from the base of the column for treatment by magnetic or gravity separation.

TABLE VIII — COMPARISON OF ORE BURDENS IN NORTHERN AND SOUTHERN FURNACES, POUNDS PER LONG TON OF METAL PRODUCED

Item	Northern Furnaces				Southern Furnace	Average of 14 Northern Furnaces
	1	2	3	4		
Ore (dry basis)	3204	4435	4218	4474	4200	3970
Limestone	823	2000	839	1267	1253	906
Ore and limestone	3927	6435	5057	5741	5453	4876
Iron in ore, per cent	53.9	49.9	50.9	53.4	43.2	51.9
Iron, pounds	1726	2213	2147	2389	1814	2060
Iron in ore and limestone, per cent	43.9	34.3	42.5	41.6	34.2	42.3

Some such method might be used and probably will be adopted for the treatment of the existing deposits of low-grade high-silica iron ores which are not amenable to concentration. It is even possible that some such method may supplant the present-day furnace when high-grade ores have been depleted.

Evidence of the approach of such a change in the present-day blast-furnace process and ore supply at this time is shown by the fact that a number of southern furnace companies have deposits of hard red ores, not amenable to concentration, and contain 30 per cent of iron or less and 19 to 30 per cent of silica. In furnace operation these ores have heretofore been used with rich brown ore, but as the brown ore represents only 30 per cent of the production of the Birmingham district it is obvious that it will not be feasible to obtain sufficient quantities to mix with the low-grade red ores for an indefinite period. Other companies have two ore beds, low and high grade, and naturally the low-grade has been abandoned for the high-grade ore. Conservation of resources and a reduction of mining costs would be effected if the two beds could be mined together, as will be shown in Bulletin 239 of the Bureau of Mines, "Methods of Mining Red Iron Ore of the Birmingham District, Alabama", by W. R. Crane, now in the press.

It is obvious that the low-grade ores cannot be worked economically in the present-day furnace, also that we are slowly drifting to a point where the lower grade must be considered; would it not therefore be wise at this time to consider ways and means?

Summary.

It has been pointed out that in the production of iron, certain constant quantities of heat are required for the reduction of the oxide to the metal, and this quantity is practically constant in all furnaces. Average results of heat balances of a number of northern furnaces have been compared with results of a heat balance made on a southern furnace. These results point out that more heat is required in southern practice, over and above that required to reduce the oxide, than in northern practice, also that the quantity of heat required over and above that to reduce the oxide will increase as the iron content of the ores decrease. It is suggested that as heat requirements increase we are drifting toward a change in the method of treatment which will probably result in the adoption of one of the so-called direct processes.

Acknowledgments.

Acknowledgment is made to the officials and men of the Central Iron & Coal Company, Holt, Alabama, for co-operation on this and other investigations; and to E. P. Barrett, A. C. Fieldner, T. L. Joseph, and P. H. Royster of the U. S. Bureau of Mines for criticism of this report.

Something New in Annealing Boxes

A new and unusual type of annealing box is being developed. It is well known by those skilled in the art that large annealing boxes, if not stiffened by some means collapse very readily when in the presence of the intense heat to which they are subjected. In large boxes made of steel plates this stiffening is usually accomplished by riveting angle irons or other structural braces to the interior or exterior of the boxes. One objection to this built up form of construction is that the rivets become loose or burn off and admit air into the boxes. Another objection is that the boxes cannot be repaired when they become distorted. Other boxes are made of cast steel with a series of ribs cast integral but such a construction is not only heavy, requiring a long time for the heat to penetrate the walls but the walls thereof become fire cracked thereby rendering the box useless.

The object of this new type of box shown in the figure is to provide an annealing box in which these objections shall be obviated, a box produced of steel plates reinforced with corrugations or ridges and one which can be repaired when it becomes distorted by continual use. This also makes a very rigid and strong box but one free to expand and contract and yet remain air tight. The corrugations or ridges in the box are so formed in the body of the box that the material in the corrugations remains substantially the same thickness as that of the rest of the box. Which of course is not true of the ridges or corrugations of a cast steel box.

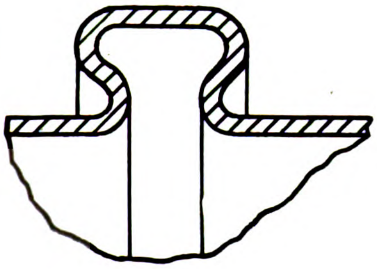

FIGURE 3

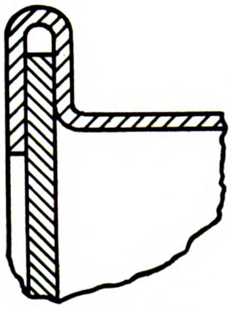

FIGURE 2

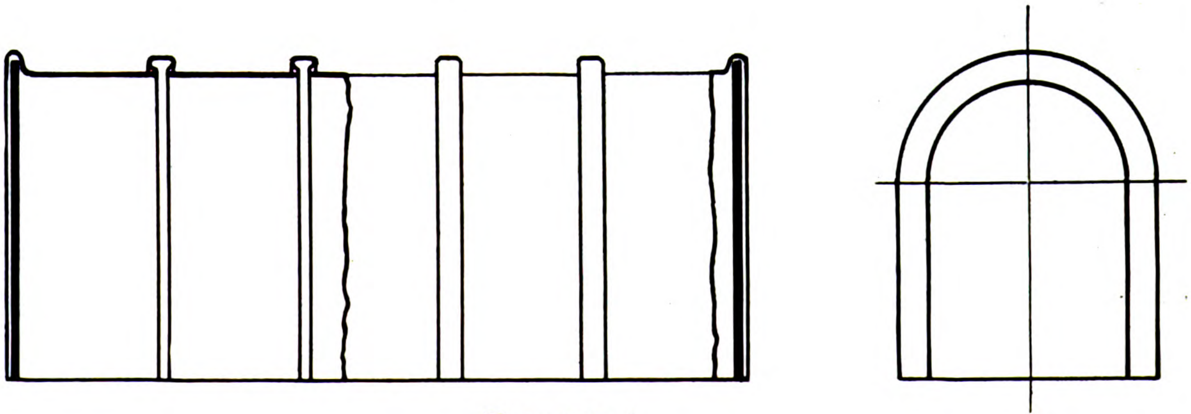

FIGURE 1

Some Common Defects in Large Forgings[*]

Some of the Common Defects Encountered and a Brief Explanation of Their Causes—Methods Used to Insure Uniform and Homogeneous Material Explained

By J. FLETCHER HARPER[†]

THE object of this paper is not to imply that all large forgings are defective or in any way to condemn their use, but to point out to designing and operating engineers some of the places at which defects may be encountered.

It must always be borne in mind that the type of stress which exists in the part and the nature of the operating conditions determine in many cases the danger of a slight flaw or defect. In many cases the seriousness of flaws or defects cannot be accurately determined by laboratory means, and it is only after years of experience under actual operating conditions that one can disregard certain defects in certain types of equipment which must be the cause of rejection in other equipment.

The statement is often made that the materials of today are not as good as they were formerly. This is not true; they are infinitely better today, but the masses used, the speeds operated at, and the temperatures and pressures now found in modern apparatus were not even considered a few years ago. It is this new order of things which calls for greater uniformity and homogeneity of materials. Most engineering formulas are based on a uniform material, but steel makers and fabricators assert that no such material is possible, or made, in the strict meaning of the word, and the formulation of an estimate of the seriousness of any defect in a specific piece of apparatus therefore becomes a compromise between theory and practice.

In considering defects found in forgings, it is well to classify them under two heads: first, those inherent in the material; and second, those caused by the method of fabrication. It is very common to have both kinds present, and it is entirely possible that one may so mask or accentuate the other as to make any definite conclusions difficult.

The most common defects inherent in the material or the ingot from which forgings are made, are:

1—Variations in composition
2—Piping and gas pockets
3—Cracks
4—Slag lines and "ghost lines."

Variations in Composition.

In the manufacture of large forgings, large ingots, which in reality are only steel castings of the highest type, are required. Such castings will naturally have varying cooling rates, and it is a law of solutions—and steel is a solution—that the higher concentrations will solidify first. It is only natural, therefore, that the chemical composition will vary somewhat from the bottom to the top, and from the center to the outside, of the ingot.

This variation, if not excessive, is of no great importance. The slight variations in physical properties from one end to the other can usually be corrected by heat treatment of the forging; and it is the usual practice to test the forging midway between the center and the outside to get the average results.

However, any practice in which two heats of steel are utilized without the employment of a large mixing ladle, or in which two ladles of steel are poured without the use of a common runner box, should be frowned upon.

Piping and Gas Pockets.

As stated before, an ingot is nothing more than a very special steel casting, and as such it is subject to many of the defects of steel castings.

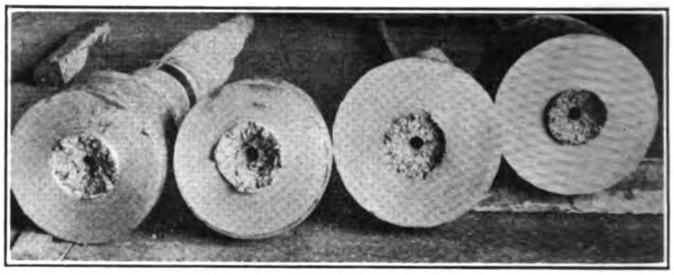

FIG. 1. — *Examples of hidden piping.*

The mold, in the best practice today, is made of special cast iron. The laws of freezing of metals cause the outside surface next to the mold to solidify first, and as more heat is absorbed by the mold this skin grows in thickness. This thickness grows more slowly as the metal solidifies, due to the increased mold temperature and the insulating effect of the skin, causing the center to remain molten for a considerable time.

This freezing action is accompanied by contraction which causes the molten metal in the center portion to decrease in height, giving the hollow, cone-shaped upper portion known as the "sink head" or "pipe." If the rate of solidification is not proper, the outer portions of the ingot, being rigid, will exert enormous stresses on this inner semi-solid material, causing tearing or extension of the pipe.

This tendency to tear is further increased due to the rejection of the impurities into the last material to solidify. This action is more fully explained under the discussion of "Cracks."

Ingots of proper design as to shape and cooling rates should have the pipe or shrink entirely confined to the upper portion. But if due to improper design, or if two heats or ladles of material are improperly used, or the pouring or cooling is stopped at any one point, the ingot can easily have piping throughout its length or in several places. The surfaces of these pipe cavities are usually oxidized, which prevents any possibility of welding in subsequent forging operations.

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[*] Paper presented at the Spring Meeting of the American Society of Mechanical Engineers, Milwaukee, Wis., May, 1925.

[†] Research Engineer, Manufacturing Department, Allis-Chalmers Manufacturing Company.

The two forgings shown in Fig. 1, which have been cut in two, show examples of hidden pipe. In the case of both forgings the defects shown are due to secondary piping, for ample material had been cut from the top of the ingots to remove all normal shrinkage.

Gas pockets or blowholes are due to the rejection of gas by the molten steel at the time of solidification. If the solidification is normal, that is, progressing from the outside inward and from the bottom upward, the gas is carried into the sink head. But if the freezing takes place above molten metal and this gas collects, there will be a gas pocket which will cause trouble.

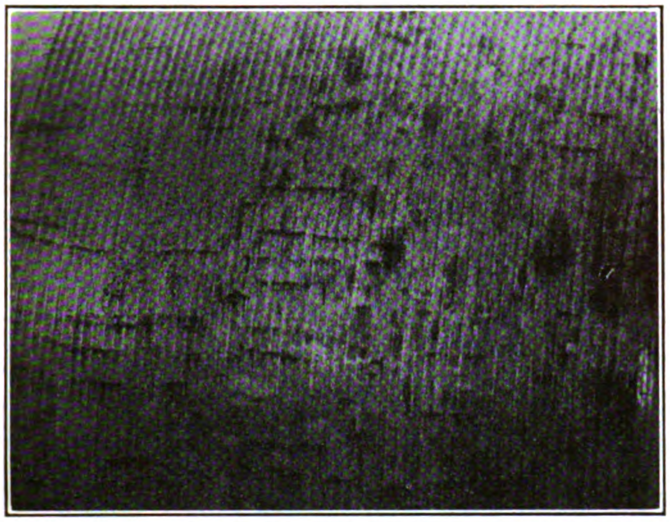

FIG. 2. — *Ghost lines in the machined surface of a shaft.*

If considerable gas is present, a number of small bubbles will probably form just below the skin of the ingot and escape outward, leaving tiny "worm holes." The holes are usually oxidized and cause surface seams on forging or rolling. The extent of these seams is dependent on the depth of the gas "worm holes."

Cracks.

If the surface of the ingot is not properly designed or the surface of the mold is rough or full of holes, natural contraction cannot take place and the ingot will crack.

Solidification begins about various centers which are at the lowest temperature, which results in the formation of crystal skeletons. These skeletons rapidly develop branches which become more and more coated with crystallizing matter until the whole resembles a tree or is, as it is termed, "dendritic."

In the case of an ingot the formation of a number of dendrites proceeds simultaneously from the chilled surface of the iron mold until they interlock and the whole material is solid. Impurities, having the lowest freezing temperature, will be carried in the mother liquid until final solidification, when they will be trapper between the dendritic branches.

If the dendritic formation proceeds from two surfaces it forces the non-metallics in the molten material to their extremities, until, when the dendrites interlock, a plane of inclusions is formed.

This plane of inclusions is a plane of weakness and can be the cause of a serious crack in an ingot and the forgings therefrom; and it is for this reason that the shape of the ingot mold, as regards surface, is designed so carefully, in order to obtain the maximum cooling surface with the minimum of corner segregation.

Slag Lines and Ghost Lines.

"Ghost line" is a rather indefinite term applied to a frequently encountered defect. Ghost lines are streaks varying in composition from the major portion of the metal and usually containing slag impurities. They usually show up in the machined surface of the forging as light or dark marks, depending on the angle at which the light strikes the machined surface. As mentioned before, the material in these lines differs in composition from the rest of the steel, being usually very low in carbon and high in phosphorus. These lines differ in hardness from the surrounding material, which causes the tool to jump in machining and the lines to show. The depth of these marks is usually very small, so that with a very slight removal of material they disappear. However, when present they usually occur in many groups, and when one is removed, another appears.

The danger from these lines is a much-debated question. It can be safely said that in straight tension the strength of the material containing the lines differs little, if at all, from that of adjacent material containing no lines. However, the action under reversed stress is another matter, and that under temperature changes appear to the author to be detrimental. Being of radically different composition, the expansion and contraction are different from what they are in the surrounding material. It is because of these two unknown variables, reversed stresses and temperature variations, that ghost lines are prohibited in high-class equipment.

Fig. 2 shows the machined surface of a shaft illustrating a bad condition of ghost lines.

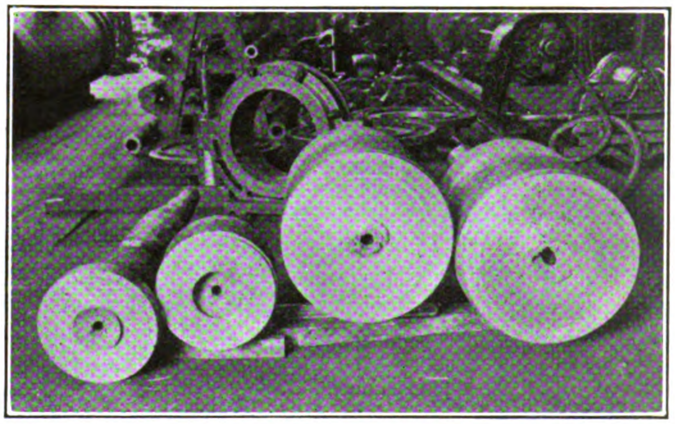

FIG. 3. — *Shafts showing the clink type of defect.*

Defects due to fabrication may be classified under the following heads: 1, Laps; 2, Star cracks; 3, Clinks; 4, Improper reduction; 5, Heat treatment.

Laps.

Laps are the folding over of the surface of the metal in the forging operation. This type of defect is usually due to working the metal too much in one direction before rotating it, or to the use of improper forging dies. It can also occur with proper working

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and die equipment if the shape of the ingot surface—the corrugations—is not correctly designed.

In large forgings this type of defect is usually not serious, as the amount of stock left to be taken off the rough forging in the machining operation is usually sufficient to remove all traces of the lap. However, the surfaces of a lap are covered with a scale which is folded under, and the lap may be so severe as to cause actual tearing of the metal. It is purely a case of bad forging practice and should be looked upon with suspicion, as other poor practices often accompany it when it is allowed to exist.

Star Cracks.

Star cracks, so called from their most familiar shape, are another form of bad forging practice. They are formed in the center of a shaft and are usually not seen unless the shaft is bored. The common cause of this type of failure is forging after insufficient heating, that is, working the hot outer portion over the cold center and causing it to fracture.

Forging a large section on too small a hammer or press, or forging it down round instead of square as far as possible and then rounding it up, can also produce these defects.

Clinks.

Clinks are one of the greatest possible dangers in the making of large forgings, and while they are not necessarily produced by bad practice, they are the result of not exercising proper care.

In the casting of large ingots or even small ingots of alloy steels, enormous stresses are set up in the cooling. If this cooling is allowed to extend below about 1000 deg. F. without being equalized, these stresses usually reach such a point as to cause rupture. It is therefore considered good practice not to allow a large ingot, or the forging from it, to cool completely until it has been heated uniformly to above the critical temperature of the material.

It is obvious that it is often impossible to get the cycles of operations to come so that they will allow the completion of the forging before cooling. It is often necessary to ship ingots to other plants for the forging operation, but in all such cases they should be annealed to relieve the casting strains.

On reheating an ingot, the rate of heating until the center portion has passed the temperature of 1000 deg. F. should be very slow, otherwise the expansion of the outer portion will cause a clink.

The reheating of a forging which is partially forged and the equalizing of the temperature of the finished forging are operations which demand the greatest of care and experience if this class of defect is to be eliminated. The occurrence of clinks increases with the size of the work and the use of the denser alloy steels.

Fig. 3 shows two shafts which have been cut in two and which exhibit the clink type of defect. A comparison between the defects in this illustration and those of Fig. 1 clearly shows the different characteristics of these two types of defects. The defects due to pipe have a coarse-grained, heavily oxidized surface, while the clinks exhibit a clean rupture of solid metal.

Fig. 4 shows a piece of partially forged ingot which has ruptured. This ingot, which was 23 in. in diameter, was heated and forged to approximately 21 in. square; the ingot corrugation can still be seen at the corners. This piece of material cooled down and was set to one side with no care being exercised to relieve the strains set up by the heating and slight forging. Six months later it fractured as shown as a result of internal stress. The material was perfect, containing no flaw of any nature.

Improper Reduction.

The major object in forging a piece of steel is to break up the grain size found in a steel casting and to increase the density and homogeneity of the material.

To accomplish this the original area of the ingot must be reduced. In order to gain the maximum advantage this reduction should be in a direction at right angles to that in which the maximum stress will be applied in the finished article. Furthermore, the physical tests made to determine the characteristics should be taken at a position to determine this condition of maximum stress.

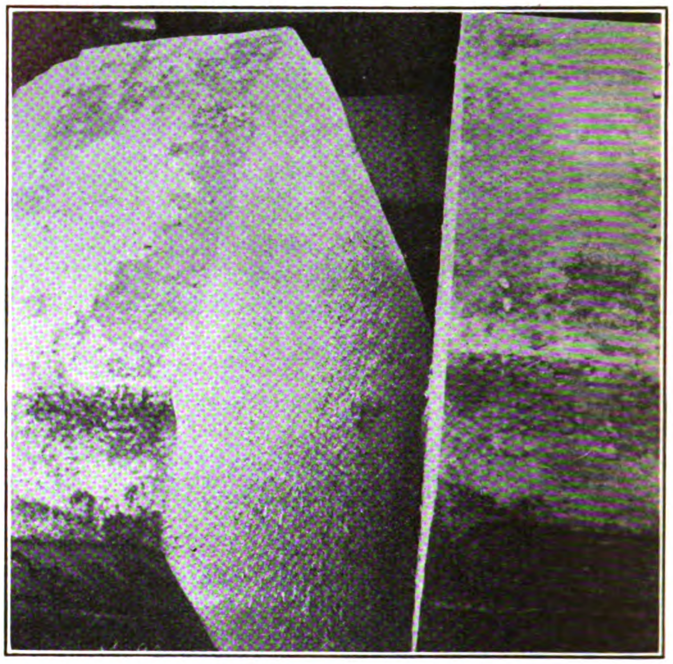

FIG. 4. — *Fracture of partially forged ingot as a result of internal stress.*

Reduction causes the dendritic crystallization and the secondary crystallization to be elongated at right angles to the applied force. This produces what is commonly termed "fiber," and greatly increases the physical properties in the parallel direction but at considerable sacrifice to the transverse ductility.

It is for this reason that ring forgings are forged by expanding over a mandrel and tested tangentially. While it is impossible to work some material, such as turbo rotor shafts which are so stressed and tested radially, by expansion, the Allis-Chalmers Company has found that by proper heat treatment a fairly large reduction, with its accompanying advantages, can be made with no sacrifice in strength or ductility in any direction.

Because of the fibering of the structure of forgings, care should be exercised that a change of dimension in the forging operation is made by a flow and not by a sharp cut-off. If the flow of material is not obtained a weakness at the points of changes in diameter is experienced.

Heat Treatment.

Defects due to the heat treatment of forgings is one subject which would demand many pages for its consideration, even in very rough outline. However, there are several major points of caution which can well be mentioned.

Any heat treatment should be applied only after all forging operations have been completed.

The heating and cooling should be uniform and applied to the entire mass, eliminating all possibilities of local heating or cooling of any part.

In large forgings the effect of mass must not be considered, and time must be allowed for the complete penetration of the heat. It should be appreciated that there is a certain amount of inertia present which resists structural changes, and that the larger the mass, the greater will be the length of time necessary to accomplish any change.

Any heat treatment that obtains high physical strengths but leaves the materials in a highly stressed condition, should be avoided.

A uniform distribution of the microscopic constituents in as fine a size as possible should be the desire, in order to prevent cleavage planes of weakness.

The Allis-Chalmers Company has found that to secure good large forgings the following precautions must be taken, not on one or two forgings, but on each and every forging.

The ingots used for making the forgings must be made under careful supervision as to material melted, method of melting, temperatures obtained, pouring conditions, and mechanical handling.

The forging operations are closely controlled as to the heating and forging. The forge department is apprised of the stresses under which the finished piece will operate, in order that it may get the maximum results attainable by reduction and heat treatment before making the forging.

The physical tests are so made as to be representative of the forging, and in such a manner as to check the operating stresses in the finished machine.

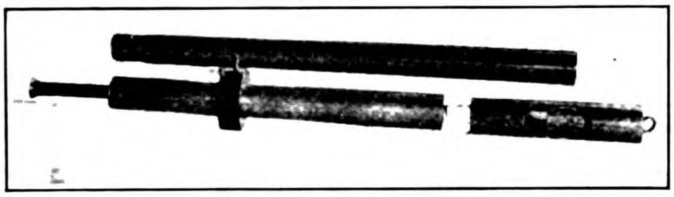

FIG. 5. — *Periscope used for examining the bore of a shaft.*

The heat treatment and chemical characteristics are checked by careful microscopic examination and analysis before the forging is released by the metallurgical department.

All laps, cracks, seams, or surface defects are completely chipped out before the piece is machined. Great care is used to see that all traces of the defect are removed, even to the extent of etching and examining with the microscope. In defects of this kind there is great danger that the metal at the base of the visual crack will be found to be distorted or microscopically ruptured, and if such material were allowed in service, there would be risk of fatigue failure.

All shafts over 9 in. in diameter have an exploratory hole (1½ in. in diameter or larger) for use in periscopic examination.

There are several types of periscopes for this work, but the one which has been used with success for the past ten years is shown in Figs. 5 and 6.

This instrument consists of a brass tube, the inner end of which contains an electric light for illuminating the bore, and a reflecting prism. The outer end has a focusing telescope, the object of which is to bring the image up to the eye, and not to magnify it. This equipment allows the slightest flaws to be detected within the bore of the shaft.

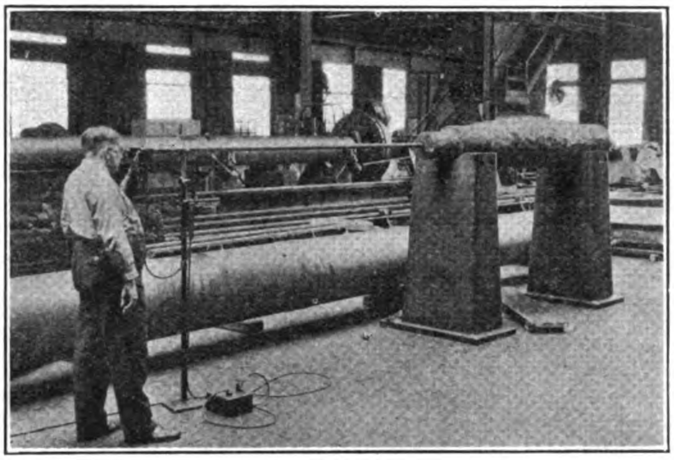

FIG. 6. — *Periscope of Fig. 5 in use.*

It is believed that with the careful observations as outlined above, large forgings today offer the best means of securing homogeneous material. However, a full understanding of the nature of defects and their reference to operating stresses should be thoroughly understood by all operating and designing engineers. It is this neglect to realize the limitations of large forgings which has caused them, through failures, to fall into disrepute; while in reality they are today one of our most uniform materials of construction.

The Youngstown Sheet & Tube Company in Youngstown, Ohio, a few years ago ordered a complete outfit for the manufacture of seamless tubes up to 13 inches in diameter. The order was secured by the two German manufacturers, Gebr. Meer-M. Gladbach, and the Deutschen Maechienenfabrick, a.g., in Duisberg. These two concerns are considered to be leaders in the manufacture of this line.

The Republic Rolling Mill Corporation, 110 South Dearborn Street, Chicago, Ill., recently organized, will operate the former bar iron plant of the Republic Iron & Steel Company, located at East Chicago, Ind. The new organization is said to be arranging for extensive production at the mill and will develop to a maximum basis as soon as conditions justify.

The Sharon Steel Hoop Company, Sharon, Pa., has completed repairs and improvements in its Mary blast furnace at Lowellville, Ohio, including relining, and plans to place the unit in immediate service under maximum output. The stack has been idle for the betterment program for some time past. The resumption will give employment to a large working force.

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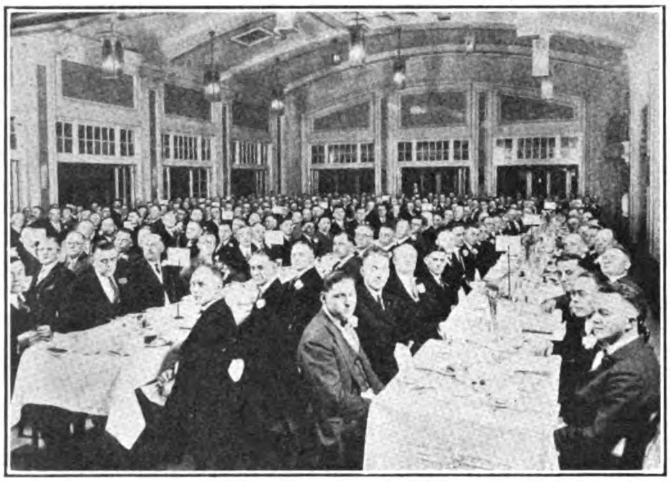
Safety—Gary Works Dinner—Records*

Several Hundred Employes and Guests Hear General Superintendent Gleason

SATURDAY, April 18, was a red-letter date for those present at the dinner given by General Superintendent W. P. Gleason of Gary Works, Gary, Ind., at the new Lake Front Pavilion to 260 department heads and foremen, in appreciation of the splendid coke, iron and steel production records which made possible new rolling mill and shipping records during the month of March, 1925. In addition to production was another record even more commendable, namely, the plant safety record. This was the best in the history of Gary Works, and the more commendable and gratifying to all concerned because it was made during a month when the works operated at a record breaking production rate. One can scarcely visualize the enormous tonnage of raw materials handled each day, the energy consumed in the reduction and refinement necessary to produce the steel; the heating, roughing, and rerolling required before the steel becomes finished or semi-finished products; the transportation facilities at command to handle the raw materials; to transport the great tonnages in the course of manufacture and to eventually assemble the marketable products for the ultimate consumer. Nearly 14,000 men took part in this cycle of refinement and production. Where the human element is such an important and vital factor it is certain that had not "Safety" been in the hearts of the entire Gary Works organization such a record would not have been possible.



Gary Works dinner, at Lake Front Pavilion.

The new pavilion is indeed an ideal place for such a gathering and its ever increasing popularity is well earned. The massive, well planned building, in its scenic location, with the mirrored lagoon extending to the west and the beautiful drives to the lake shore on the east with the surrounding landscape lending the charms of the dune country, makes a picture delightful to the eye. Surely Mr. Gleason as president of the Park Board of the city must feel the keenest satisfaction in the realization of his dreams of this magnificent civic recreation center. The scene takes on its most beautiful aspect just about sundown, and it was about this hour that the diners gathered on the sun porch, meeting new faces and renewing old acquaintances. There were present "old timers" who had long since been called to other important positions, some of them coming from distant places to grace the occasion with their presence. Paul Menke, "Bill" Giesman, George Lowell, "Bill" Bailey, "Charlie" Wheeler, "Jim" Jones and Dr. Miltimore were there. After the informal reception, the guests found their places in the main dining room.

The dinner was opened by singing "America," followed by a short address of welcome by Mr. Gleason, who opened his remarks with the following quotation from Emerson:

"Rich indeed is the man who avails himself of the faculties of other men." Mr. Gleason spoke of having watched for 19 years the progress of the city and works, and of the development from perhaps the most uninviting spot on the shores of Lake Michigan. He complimented his organization upon the records of March and, alluding to the production figures, stated that with all these great tonnages there was the smallest number of accidents for any month in the history of the works. Mr. Gleason stated that this safety record was especially gratifying and wished to express his appreciation of the remarkable work and co-operation of his organization, who rendered such a valuable service in contributing so largely to the happiness of the 14,000 employes and their families, due to the fine accident prevention record of March.

During the dinner a telegram was handed to Mr. Gleason, supposedly from one of the Chicago broadcasting stations, who were dedicating a quartet number, "On the Banks of the Wabash." The number was very good and its singing seemed to invoke a spirit toward more singing by the crowd. A very efficient song leader with the aid of the orchestra kept every one pretty busy during the remainder of the dinner, singing many old tunes and popular numbers.

After dinner Mr. Gleason delivered his message, which brought out the necessity of personal relation with the employer and employe and a better understanding of men.

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*Courtesy Gary Work Circle.

Mr. Gleason's Remarks.

"I wish to take this opportunity to speak to you briefly on our relationship with our men and to further suggest some things in connection with the qualifications and responsibility of foremen and executives.

"The responsibility of those in charge of men is becoming greater all the time. In the advancement of civilization, the standard of education is increasing and becoming so much higher, and the equalization of human instinct is becoming more pronounced; therefore, the art of handling men is becoming a real science.

"The destiny of the foreman, as well as his men, is largely in his own hands. There is no mistaking that he is the key in all industry. The work fails or advances in accordance with the qualifications of the foreman, and fortunate indeed is the young man who commences work under a wise and efficient executive.

"Men as a rule are disposed to be fair and reasonable, and their aim is to do the right thing, but many are misguided or have a wrong viewpoint, and others fail to embrace the opportunity to learn and to think out clearly and logically their own problems. Nature has dealt more kindly with others, providing some with all the basic principles necessary for the greater success; others have these principles in part, but in all their formative years require the guidance and wisdom of experience, experience not only in methods pertaining to efficiency and work, but experience in nature, and it behooves all of us to extend to every man within the reach of our influence all the help that our positions will permit, and to at least deny them no right that has been extended to us.

"I wish I had time to dwell at length on the impressions I have formed and the conclusions I have reached as to the good that can be accomplished and the benefit that can reflect to the man and to his family from the proper interest taken in him by his foreman, but tonight the program will not permit.

"First, I would say that in the makeup of an executive, character is the greatest of all assets because character carries with it intelligence, honesty, perseverence, loyalty and almost every requisite possessed by successful men. With men of character as a rule comes a clear understanding of human values and the ability to handle men. It has been said, and for the moment I have forgotten by whom,

> 'Of all the blessings that it has pleased Providence to allow us to cultivate there is not one that breates a purer fragrance or bears a heavenlier aspect than character.'

"Therefore, if those in charge of men are selected as men of character, rather than because they happen to be available, the success in industry is assured, and when I say the success in industry, I mean the success of the employe and the employer.

"We know that the selection of many foremen has meant only a mistake, rather than the fitness of the man so selected, and if this mistake is not corrected, impotency and disorganization result in the degree to which this misunderstanding has been allowed to exist.

"To get along well it is necessary to have a complete absence of undue display of authority, a lack of arrogance and abuse, to be a good reader of men, and above all to have a good, honest interest in our workmen. Many workmen do not need our guidance, but if those who do can be taught or can be prevailed upon to take a proper interest in themselves, every other interest, including their employer's, will be taken care of, for in many instances and without even the employers' knowledge, the conduct of foremen and men toward one another is the real basis for prejudice and complaint against industry and the management.

"The most objectionable of all features in industry, the high turnover, usually results from indifference or inability to select the proper man for the proper place, and of determining what each man is best suited for, for it must be remembered that in every man are the elements of success in one way or another, and if the man is not able to locate these himself, it is a real kindness for us to endeavor to do so, and it is an increase in efficiency to place the man in the place for which he is best suited.

"Carefully analyzing your men will not only help to bring the men to a higher standard, but will prevent overlooking worthy men, the man who can take care of himself, and it must be remembered that there is nothing that will increase your turnover or drive good men out of the organization more quickly than to overlook their efforts and promote less capable men.

"It is important to develop labor saving devices that make the work easier and more efficient, the men more contented, and the cost less, thereby promoting the tendency to better positions and better recompense. Nothing so completely helps to fix the standard of wages as the high expense involved in the continual education of new men. The trained imagination easily visualizes where the employer's production cost is seriously increased from this source, and this results in higher cost to the consumer and less return to the employe and employer, and can only be credited as human waste and loss to all concerned.

"I am sure I am right in saying this, and in doing so I wish to pay only a tribue to the foreman when I say he may change or reduce the turnover to the lowest point if he will study and select his men carefully, and if when they are employed, he will inquire into their past, acquaint himself with their weak points, striving to correct when necessary. A kindly interest in him at all times, clear direction when he is undertaking his work, help for him in his home problems when necessary; all of this will result in the man's becoming attached to his foremen and to his work, and especially so if care is exercised in pointing out to him the advancement that may come from application and interest in his work.

"In the advancement of men and the efficiency of industry, all must be trained to clearly understand that, in whatever line of endeavor they are employed, to succeed means to work. Nothing is worth while or is long coveted that comes easy. To be worthy of promotion, to be selected for advancement, a man must do a little more than his job calls for, or else how will his superior know that he is prepared for the next higher position. Quite often men are discontented and are seeking promotion from a superior who is dissatisfied with their present work, and in fairness to the man, sometimes this environment or atmosphere is created by careless or incompetent superiors, and this is often responsible for the mental attitude of the men.

"Just a word in our safety drive. You are well aware that during the year 1924 our record in safety matters was not so good, and try as we would, it did not seem to improve. It appeared at times almost impossible to get men to take the proper interest in their safety. Every equipment, regardless of expenditure, that could be suggested as a safety measure was adopted without avail. We know that some men are careless in their homes and on the street; we know that some men are habitually careless all the time. Some time ago I was reading accident statistics for the different states, and for one of the states it was given that more people were hurt going up and down stairs in their homes than were hurt on the railroads of the state.

"It was finally decided to make an intensive drive to educate the workmen, and as we progressed during this intensive safety drive, each day added proof to me that the safety of the men lies in the hands of our foremen; so much so that we concluded that if the foreman is a real safety man, tolerating no violation of the safety rules or no man that would not work carefully, continually watching and instructing, the safety problem is solved, and that our men when they leave their families in the morning, or in the evening, should have the feeling that they are as safe as in their homes.

"This is not conjecture; we know in this we are right, and it has been borne out by the results obtained by many of our leading superintendents and foremen. The statement has been made a number of times that this safety drive would slow up the work; to this I have repeatedly given the answer that we had no right to proceed faster with our work than the safety of our men will permit, and I am glad to say that the reverse has obtained, and it is not necessary to refer further than your March record to show that when men are the safest, the work proceeds the fastest, and this has come about by your co-operation and interest, and I want to thank you. It is to me a most gratifying accomplishment, and I strongly urge you, in the interest of yourself and your fellow workmen, to continue this good work, and that you cultivate everything leading to the safety and interests of your fellow workmen.

'In conclusion, I will say that it is not my intention to talk to you at length this evening, nor to be over serious. I am anxious for you to enjoy the program, rather than to draw before you the stern realities connected with our responsibilities in industry and civic affairs, but it is only natural for me to say some of the things that I think will prove of mutual benefit to all of us, knowing that there is no equal number of men in this fast growing city of close to 100,000 souls, that has more responsible duties or can contribute more effectively to the good of their fellow citizen. And my statements are based on the thoughts obtained over almost 45 years of constant experience, and they are applicable to myself the same as to my associates, and are intended only as a further attempt to facilitate our guidance.

"It is my intention and my hope to arrange for an annual affair of this kind, and I trust that during the intervals we may so conduct ourselves that the comparison will indicate progress."

Weights of Construction Materials

The U. S. Bureau of Standards publishes the following:

In the absence of definite information establishing the weights of construction material, the following unit weights shall be assumed:

	Pounds per cubic foot
Brickwork, solid	120
Concrete, plain or reinforced	150
Cinder concrete	84
Douglas fir, cypress	36
Oak, yellow pine, maple, birch	48
Spruce, hemlock	30
Hollow gypsum partition block	48
Hollow tile partition block	60
Plaster and mortar	96

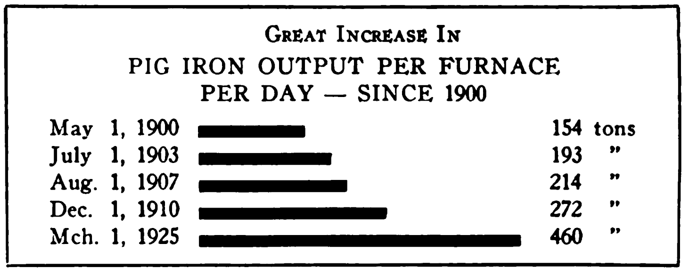
Industrial Engineering at Lehigh

Cross-breeding the engineer with the business administrator is the interesting experiment that will be launched at Lehigh University next September according to an announcement made public today of the inauguration of a new curriculum to be known as Industrial Engineering. Recognizing that every modern enterprise depends on sound financing, adequate accounting and intelligent forecasting of economic developments, the faculty at Lehigh will undertake to produce engineers as thoroughly grounded in these fundamentals of business as in their mathematics, physics and scientific subjects. The curriculum is primarily engineering in character and will equip the student with sufficient tcehnical knowledge to make him at home in a highly technical environment. In addition, however, it will include courses in economics and business that will be of service to those graduates who enter the less technical departments of any of the various industries which are essentially technical in character. The course will lead to the degree of Bachelor of Science in Industrial Engineering.

The same announcement gives notice of the discontinuance of the course in Marine Engineering, the enrollment in which had fallen off to such an extent as to convince the authorities that there is not sufficient demand for such a course.

Pig Iron Production Per Furnace Increased

An interesting phase of pig-iron production is the great increase in output per furnace during the last quarter century, as illustrated in the following chart:



GREAT INCREASE IN
PIG IRON OUTPUT PER FURNACE
PER DAY — SINCE 1900

This increase in the daily output of pig iron per furnace, with its consequent economy, was brought about by remodeling and improvements.

Another interesting item is the increasing use of steel scrap in place of pig iron in many forms of steel manufacture. The tonnage of scrap in the production of steel grows steadily, until it has become a large component in steel manufacturing.

—La Salle Bulletin.

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Storage of Fuel Oil

By R. KRAUS[*]

THE practice of storing oil in concrete tanks is well established with the oil refining companies. With the consumers the problem became acute in recent years as a safeguard for the continuous operation of their plants due to the irregularity of coal supply and the shortage of natural gas in the winter months.

For storing of quantities limited to several thousands of gallons of oil, preference is given to the use of steel tanks. In order that the problem be solved economically, and with safety, various provisions have to be made. Their advisability has been borne out by actual experience. The following survey will be found useful by those who are confronted for the first time by the problem:

1—The housing of the tank or tanks must be decided upon; same may be placed above the ground or underground. This is discussed in the latter part of article.

2—In order to keep the oil liquid enough for pumping, same must be heated, either by heating the whole pit or by placing steam coils in the tanks.

3—A pump must be provided to pump the oil to its destination, and a preheater must be used ahead of the burner nozzles.

4—The oil pit and the oil tanks must be ventilated for removal of inflammable fumes.

5—A steam line about 2 inches in diameter should be brought either in the pit or in the tanks for quenching of a fire; the operating valve for such a steam line must be located outside the pit.

6—Provide means for unloading the oil from the tank car, and arrange also a sump between car tracks, piped to the tanks; that will help to salvage the oil in case of an accident with the unloading equipment. (See Fig. 2.)

7—Compressed air must be brought in the tank car in order to increase the speed of unloading.

8—If more than one tank is used, pipe tanks in such a way as to permit of filling either tank independently of the other.

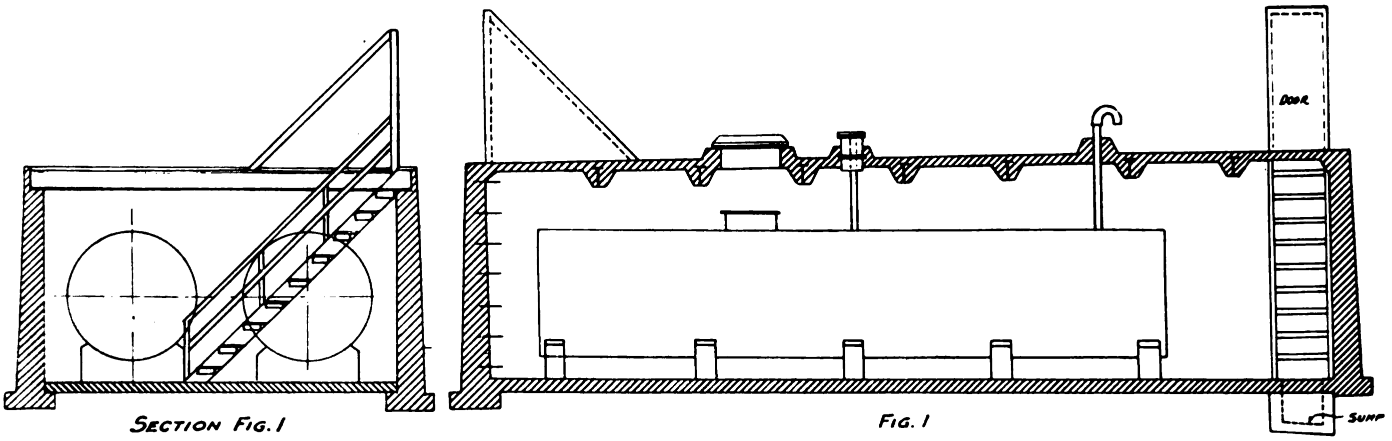
The amount of investment permissible will be largely decisive in the method of housing the tanks.

A simple steel structure above ground, built up of light angles and channels, and covered with corrugated sheet steel, is the least costly. However, it will prove expensive to heat in localities with rigid winters, and such a structure is not quite perfect, if a fire has to be quenched or localized. For a structure above ground a bricked in building is better in every respect.

Much trouble will be eliminated if the pump suction is not connected directly to the pump, but to a float with a swing joint, as shown in Fig. 3.

An underground fuel oil pit is preferable where yard space is of value and the best fire protection is aimed at. The ideal solution is a concrete pit, as shown in Fig. 1, namely, below the yard level and large enough to give all around access (of about two feet) to the tanks for maintenance by painting and caulking if leaks develop. Sufficient space should be in front of the tanks to enable the working of a scraper at least four feet long for removal of muck.

The tanks resting on piers should be enclosed about 6 in. in 30 ft. in order to promote the accumula-



Section Fig. 1 Fig. 1

FIG. 1. — *A concrete pit makes an ideal oil storage.*

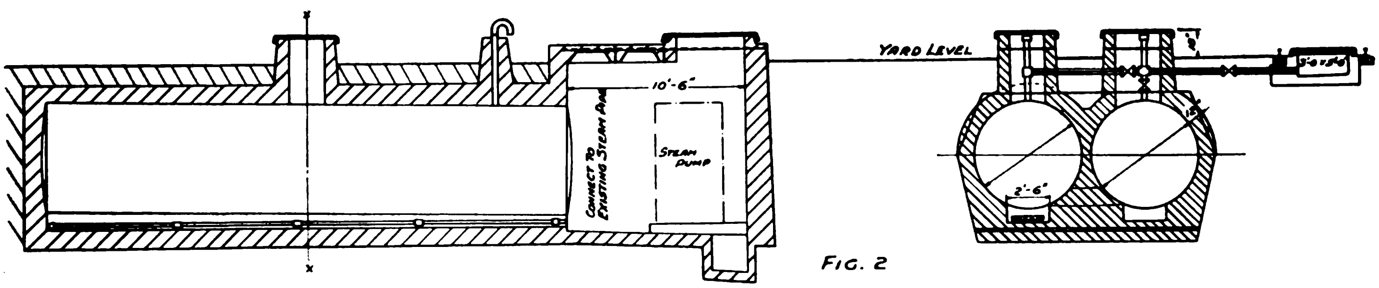


Fig. 2

FIG. 2. — *Suggests a method of salvaging oil in case of accident.*

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[*] Pittsburgh, Pa.

tion of the muck in the front end. These two provisions mentioned are not necessary with tanks 10 ft. in diameter or larger, where a man can bail out the sediment and handle the buckets through manholes.

The floor of the pit should slant in every direction toward a sump (2 ft. by 2 ft. by 2 ft.). A sump pump will also be found useful. The treads of the stairway used for regular access are best made of channels filled with concrete, which is the best protection against accidents from slippery steps. A fire escape should be provided at far end of the pit; the door must be latched from the inside only and it can be made accessible by means of rungs embedded in the concrete.

Another arrangement is shown in Fig. 2. The tanks are entirely embedded in concrete; with it there is less expense for excavation and also less cost for concrete. The expense for heating the pit is the lowest in this case. The heating coils can be placed in a recess of the concrete right under the tanks, which will make the heating very economical; this piping must be done very carefully; leaks will contribute considerably to the deterioration of the tanks.

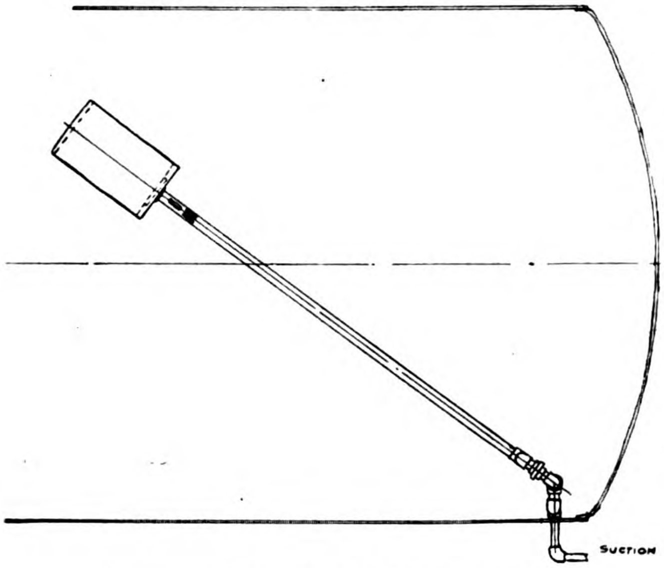


FIG. 3. — *Shows a float with swinging joint.*

This latter arrangement will require the same pump space, also the same provision for removal of muck and the same sump arrangements.

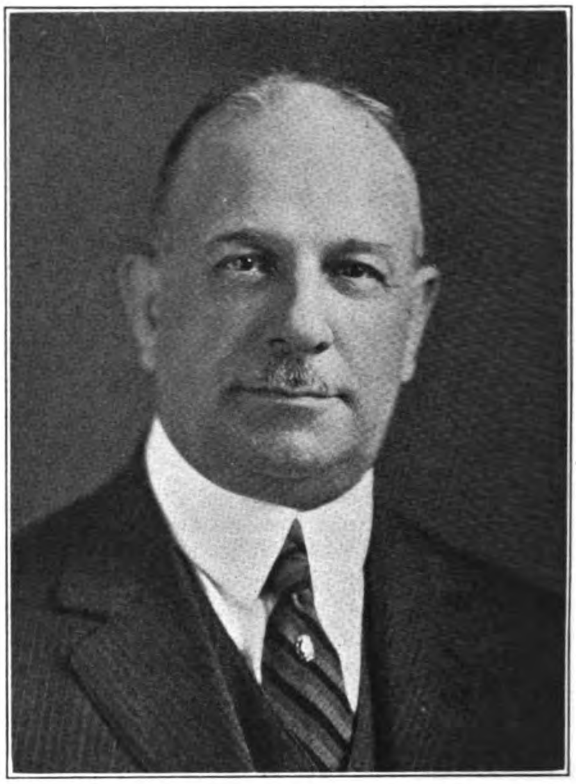
If leaks develop then the drawbacks of embedding the tanks begin to show up, because repairs are made with considerable inconvenience. Still the method of embedding tanks became almost universal with gasoline tanks.

In either design the concrete must be reinforced; in the second case a sufficient reinforcement must be provided to prevent the cracking of the concrete due to the temperature differences.

George J. Hagan, 1105 Peoples Bank Building, Pittsburgh, has been appointed representative for the Chicago Flexible Shaft Company, covering its line of industrial furnaces. These furnaces range from a small solder iron heater to the car-type annealing furnace and porcelain enameling furnace.

Pestell Vice President of Riley Stoker Corp.

William Pestell has been made a vice president of the Riley Stoker Corporation, Worcester, Mass. Mr. Pestell is widely known in the power plant field because of his many years' experience in charge of mechanical and electrical equipment for the following properties: Lynn & Boston R. R. Company, Lynn, Mass.; Worcester Consolidated Street Railway Company, Worcester, Mass.; United Electric Railway Company, Providence, R. I., and Allis-Chalmers Company, Boston, Mass.



WILLIAM PESTELL

Mr. Pestell also spent several years as a mechanical engineer for the J. G. White Engineering Corporation. He is a Fellow of the American Institute Electrical Engineering and member of A. S. M. E. He has been connected with the sales of Riley Stokers from the start of the company, first as Western Sales Manager with headquarters at Chicago, and since 1921 as sales manager with headquarters at New York and Worcester, Mass.

As vice president, Mr. Pestell will continue to have supervision of all sales for the Riley Stoker Corporation.

Mr. J. Lucien Jones, who has been with the Moss-Chase Company, Buffalo, N. Y., for the past eight years, is now advertising manager with the Andrews-Bradshaw Company, Pittsburgh, Pa., sales managers for the Tracyfier, a piece of apparatus which, when installed in the drum of a boiler, replacing the so-called "dry pipe," furnishes steam free from boiler water, drops, "suds," mist, scale particles, and suspended matter.

SHEET AND TIN PLATE

Why Hard Chilled Rolls Become Rough

An Experienced Sheet and Tin Roller Explains His Thirty Years of Observation

By HAROLD HARRIS*

IF on one mill having a rough bottom roll, the production totals 300 pairs in 8 hours, on an order calling for 30 — gauge 20-9/16 × 28⅝ × 28⅝ × 61-11/16 (a 3-cut order), bottom sheets being rough, there will result 300 × 3 or 900 rough sheets; in three turns there will therefore be 2,700 rough sheets for which roller receives the same payment as for clean sheets.

Occasionally we meet a steel worker who states operating facts as he has found them. The author of this article does not write "around his subject" but, being a roller himself, he places much of the burden for poor roll performance squarely upon the shoulders of his fellow rollers.

Such an article is stimulating in its practical frankness, especially so since Mr. Harris invites an open discussion of a vexing problem.

The Blast Furnace and Steel Plant pages are freely open to any such discussion which will benefit the industry.

These 2,700 rough sheets are then carried on through the identical procedure as the clean, that is —opened, pickled, annealed, cold rolled, white pickled and delivered to the Tinning Department; there they are given a coat of tin, sent to the assorting room where the rough sheets are rejected. Attempts are often made to overcome this original roughness by extra dipping but the percentage of recovery is extremely small, a sheet roughened at the hot mills remains a rough reject.

The manufacturer's only recourse is to class such sheets as "seconds" and offer them for $2.50 per box of 112 sheets to the jobbers instead of securing the price of $7.50 per box which is paid for prime clear sheets.

On the above basis a plant of 32 hot mills operating with rough bottom rolls stands a total loss of 86,400 sheets per 24 hours' production. Calculated on a 6 days' schedule, such a plant loses 518,400 rough sheets per week.

Admitting the foregoing, is such costly and wasteful practice justifiable? And if not, what methods should be employed to improve the practice?

Roll-turning is of course resorted to, but each time a roll is turned more of the chilled surface is turned off and the roll is weakened in its resistance to further roughening influence. The grey iron comes out more freely, and the mill requires closer supervision from the roller. There is a strong difference of opinion among rollers as to whether a hard chilled tin mill roll is easier to keep clean than a medium chilled roll. In my opinion, the harder the surface the better the performance; it is primarily a question of the "starting" or "warming-up" turn; keep a hard surfaced roll clean at the start and it remains clean all week; let it become rough early, and nothing remains but a roll change. Hard chilled rolls break more frequently and will not stand the abuse that medium chilled rolls will.

Experience has shown that the roller in charge of the mill is usually more at fault for rough rolls, whatever the age of the roll, or however many times the rolls have been turned. He unnecessarily works the rolls "too full", causing swelling at the middle of the roll, creating a bearing directly in the center of both rolls. One roll slides and grinds upon the other at this "bearing point" and causes the birth of a rib of roughness at the middle of the bottom roll. This roughness shows up about the third heat of narrow iron (say 20-in.).

The roller himself aggravates this rough condition by ordering the pair-heater or sheet-heater to keep his iron colder. Instead of using unlimited water on the roll-necks, the roller would improve matters by cutting off all water, allowing the heat in the rolls to spread throughout the entire roll surface and body. When the widest orders that the mill will roll are available the water can then be turned on.

When a mill is operated full in an over-heated, over-expanded condition, with the same amount of steam blowing on the working roll-surfaces as the volume of water running on the necks of the rolls there is a strong tendency to magnify the original roughness.

A good formula to follow would be like this:

"In warming up a mill at the start, keep the water off the necks of the rolls as much as possible on a warming up turn until you get up to the widest orders that can be worked on your mill. Then when you see you have to use water, use it very sparingly, just dribbling on the neck, not flooding; thereby doing this you keep the necks of rolls warm, not cold. This method allows the heat to spread uniformly through the body and over the roll surfaces evenly distributed. The rolls do not become full or get together and you are not forcing your rolls. Do not allow your rolls to become full or overexpanded at any time and you will have no trouble with roughness on roll or in production in the first 48 hours of operation, and you will be in control of the surfaces of your roll, you have it clean, and save yourself much polishing. You are giving your rolls a chance and a square deal, also a square deal to yourself and the management and company, as well as a clean production. Always remember full, over expanded, over heated sheet and tin mill rolls create rough rolls."

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*Woodlawn, Pa.

And the following general rules will govern the important questions of expansion and contraction:

More rolls are broken in the sheet and tin mills by working them in an over heated, over expanded condition than were ever broken from being worked in a hollow condition or any other cause in the history of this trade. Keep a uniform heat in your rolls, and whatever you do, watch the color of your rolls while working.

When you enter a pack of sheets in your rolls, and your roll surface shows a uniform dark blue color and shows up the shape of the hot pack of sheets after passing through the rolls where the steel has come in contact with the rolls, changes in color from a dark blue to a light golden or copper color, you will know then that you have your rolls in a uniformly heated condition and you are safe from roll breakage.

When your bottom roll is rough, with ribs of roughness or just rough, you will know why your iron twists and pinches on the first pass through the rolls though you have your rolls in the proper hollow condition during that heat. The explanation is this: The bottom roll, being rough like a file, pulls the bottom sheets away from the others in the pack and pinches bottom sheet, and as long as it is rough you will have this trouble of pinching and twisting the iron; as soon as you get the bottom roll clean again the trouble ceases entirely.

(In next month's issue of this magazine there will be a full description of the patents recently issued to the author covering a novel method of surface maintenance for sheet and tin mill rolls.)

Napier's Valuable Rule

By W. P. Schaphorst, M.E.

Many users of steam do not appreciate the value and usefulness of Napier's rule. It is used, generally, wherever steam is allowed to flow directly from high boiler pressure into the atmosphere, as in furnaces for creating draft, in soot blowers or in heaters, etc.

The rule is: "Multiply the steam gauge pressure in pounds per square inch by the area of the opening in square inches and divide by 70." The result is the weight of steam in pounds flowing through the opening every second.

To make this rule a little more applicable:

"Multiply the steam gauge pressure in pounds per sq. in. by the area of the opening in sq. in., then multiply that by the cost of fuel in dollars per ton of 2,000 lb., then multiply that by 0.257 and into the result divide the number of pounds of water evaporated into steam in the boiler or boilers per 10-hour day.

For example, what is the cost of steam per 10-hour day flowing through a half inch round opening for creating draft in a furnace where the gauge pressure is 100 lb. per sq. in.; fuel cost $4 per ton; and 8½ lb. of water are evaporated into steam per lb. of coal.

It is easy to figure or determine by means of tables that the area of a half inch round opening is 0.196 square inch.

Then substituting in the above rule we get $3.32 per 10-hour day as the cost of the steam.

A number of years ago I carefully checked this rule in a university engineering laboratory and found that it gave surprisingly accurate results.

Eastern States Blast Furnace and Coke Oven Association Hold Annual Election

THE Youngstown district entertained more than 200 members and their guests when the Blast Furnace and Coke Oven Association gathered at the Youngstown Country Club, June 4.

This virile technical organization, which began its useful life in July, 1921, has more than justified its existence. Founded upon the idea of interrelated discussion of plant problems and co-operative research, it has succeeded in drawing closer into harmony more than 200 members, all of whom are actively employed and interested in the operation, construction and design of blast furnaces and coke ovens.

Members as far west as Chicago and as far east as New York, including guests among open hearth men, listened to Mr. F. W. Sperr's paper on "The Purification of Coke Oven Gas, with Particular Reference to the Preparation of Gas for Open Hearth Furnaces."*

During the meeting, the visitors divided into groups and visited various of the great Youngstown plants, the Republic Iron & Steel Company, the Youngstown Sheet & Tube Company, including Brier Hill, the W. B. Pollock Company, Sharon Steel Hoop Company, Carnegie Steel Company's Ohio Works, Trumbull Steel Company and its world's record blast furnace.

Following speeches by the retiring officers, L. E. Riddle, president, from the Carnegie Steel Company, and H. E. McDonnell, secretary and treasurer, from the Weirton Steel Company, new officers were elected as follows:

President, D. M. Rugg, Superintendent Donner-Hanna Coke Corporation, Buffalo, N. Y.; vice president, H E. McDonnell, superintendent of blast furnaces, Weirton Steel Company; secretary-treasurer, C. R. Meissner, superintendent by-product coke plant, Weirton Steel Company.

Announcement was made of 16 new members who were introduced to the gathering.

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*This paper by the Chief Chemist of the Koppers Company of Pittsburgh will be published in full in the August issue of this magazine.

British Research Committee Reports on Steels for Cutting Tools

By A. C. BLACKALL*

VALUABLE reports have recently been completed by the Cutting Tools Research Committee set up in Great Britain. In one, Demster Smith, M.B.E., and Arthur Leigh describe experiments with lathe tools on fine cuts and some physical properties of tool steels and metals operated on. In another, Professor E. G. Coker, D.Sc., F.R.S., gives some results obtained with a machine that could be used as a planing machine or a milling machine for transparent sheets of material, the latter being so disposed that a polarized beam of light could be transmitted through them and the stresses produced by the tools on the work measured by observations of the color bands.

A special machine was fitted to allow of the operations described in Professor Coker's report being carried out. In the operation of planing color bands, similar to those which occur with turning, were found to spring from or near to the point of the tool. A perfectly shaped tool produces shavings with brilliant colors due to overstress, but at the zone of operation a black patch occurs. One interesting phenomenon observed was that a planing tool running back after making a cut is not in contact with the work. This is especially the case when a rough cut is made. The shaving removed is thicker than the cut as measured by the micrometer feed. In the case of a smooth cut this gap between the tool and the work is small. Experiments made on brass with tools which are known to give smooth surfaces showed that no gap occurred.

The phenomenon was, therefore, observed under a microscope with a magnification of 40. This served to show that in the cases in which a gap was produced, the tool pulled up the metal locally, so that ruled straight lines on a plate developed bulges under the tool point. In one case the surface lift on brass was 0.003 in. and a line 0.008 in. below the cut surface was lifted 0.001 in., while a similar line 0.024 in. below the surface was lifted 0.0005 in. Further experiments showed that in the absence of lubricant the surface distortion in front of the tool is such that there is a demarcation between the overstressed region and that which only suffers elastic deformation. This boundary curve partly falls below the line of the cut. The action is, however, markedly different when only a trace of lubricant is present. The boundary curve is then always above the line of the cut, and this must be associated with the ease with which a smooth surface is rendered possible by means of a lubricant.

Here the actions are remarkably different from those associated with planing. In the case of milling the shaving is not uniform, owing to the fact that the tooth-point describes in general an oblate trochoidal curve, due to the combined action of the rotation and feed. Such cutters produce results which are in part influenced by the presence of neighboring cutters. With a single cutter the area in front of the cutter is in compression, while that to the rear of the tool is in tension. With two or more cutters in action near to each other there is, in general, a region between two teeth in which the pull of one tooth is neutralized by the push of the one advancing behind it. This phenomenon is described and discussed in some detail. A number of observations were made in which three cutter teeth were engaged simultaneously. The progressive advance of the place of zero stress as the cut proceeds was very marked.

It would seem that the photo-elastic method of investigating the action of cutting tools has reached a stage which indicates reasonable prospect of carrying out fundamental investigations which will have for their object the measurement of stress in both work and tool. Up to the present it has been found impossible to use a glass tool as a transparent material in which to determine the internal stresses. Alternatively two tools, one of steel and the other of hard nitro-cellulose or bakelite of precisely similar shape, may be used. A convenient cut is made with the steel tool, which is then suddenly stopped and exactly replaced by its transparent counterpart, this being advanced until it is acting as far as possible in the same manner as the steel tool, and from this the actual distribution may be found by increasing all stresses in the ratio of the total forces exerted.

But photo-elastic laws can hardly be applied with accuracy in cases in which very high stresses are involved. It would, therefore, seem necessary to gain more accurate knowledge of these laws, and this subject is engaging attention at the present time.

In the report of Dempster Smith and Arthur Leigh it is stated that a large number of investigations have been made with metal-cutting tools to determine how the durability of the tools is affected by changes in the depth of the cut, traverse, cutting speed, cutting angle, section of the tool steel, contour of the cutting edge, and the material operated upon. In the main the tests were made with single cutting edged tools of the lathe type on comparatively coarse cuts, and were undertaken with the object of finding the most economical cutting speeds for use in the workshops.

While the speed-durability curves for heavy cuts show that the durability decreases continuously as the speed advances, E. G. Herbert has shown that for light cuts the durability increases with the speed up to a maximum, declines and increases again to a second maximum, and finally falls off at higher speeds. The experiments were made on the Herbert tool-testing machine, the work taking the form of a tube rotated against the tool held in a special vice. The point of the tool was free, and only the cutting edge beyond the point was in contact with the tube, and on account of these special conditions the results have been the subject of controversy. To verify the irregular durability when taking very fine cuts at different speeds it was decided to carry out a series of trials in an ordinary lathe with a cut 0.0625 in. deep and 0.0013 in. traverse, these dimensions approximating closely to those of Mr. Herbert.

(Concluded on page 299)

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*London, Eng.

CURRENT REVIEW

New Coke-Oven Types*

Carbonizing Capacity, Temperature Distribution and Heat Consumption

By DR. ING. OSWALD PEISCHER†

PART I

COMPETITION combined with an inventive mind, which never fails to recognize technical needs at the proper moment, is the unremitting incentive to technical achievement, and without competition a growth in the direction of technical and economic perfection is not conceivable.

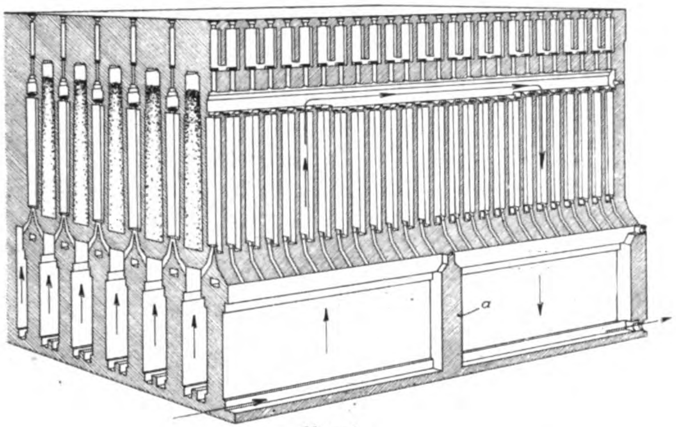

FIG. 1

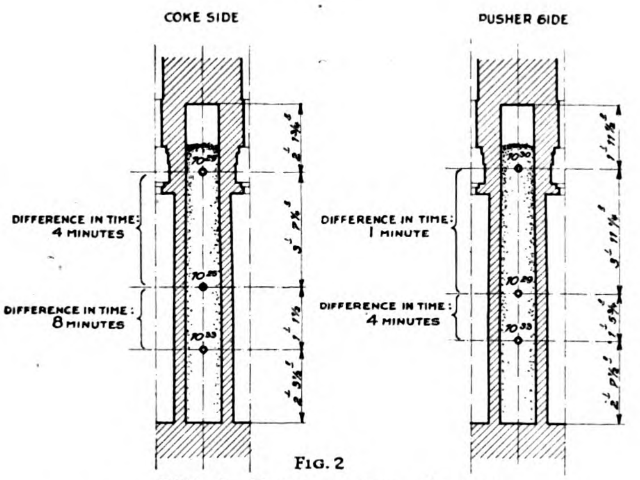
COKE SIDE
PUSHER SIDE
DIFFERENCE IN TIME: 4 MINUTES
DIFFERENCE IN TIME: 8 MINUTES
DIFFERENCE IN TIME: 1 MINUTE
DIFFERENCE IN TIME: 4 MINUTES

FIG. 2

FIG. 1—*Koppers taper coke oven.*
FIG. 2—*Indicates the time of reaching a temperature of* 800 *deg. C. measured in center of chamber.*

Thus, ever since the use of closed ovens came into use, new suggestions as to coke oven construction have been continually forthcoming; since 1921 particularly, enormous progress has been recorded, the industrial and economic effects of which are only now being recognized to their full extent. At the same time it was seen that the real origin of the most essential features of the progress made was not clearly apparent and was frequently claimed for one type of construction alone, although the same result obtained also with a different type of construction had its origin in a technical improvement peculiar to both and the difference in the two designs was of quite secondary importance. In particular, the American coke-oven construction industry appeared to be not quite free from such tendencies. The result was obscurity and confusion in the views as to the technical causes upon which the economic results were based, which views are in need of elucidation.

As the result of the technical development of the coke oven in the last few years, the following are found:

1. Increased coking capacity of the oven.
2. More uniform heating.
3. Reduced heat consumption.

Coking Capacity.

The coking capacity depends on the length and height of the coking chamber, and in proportion as these dimensions of the chamber are increased, efficiency is enhanced. These dimensions cannot be increased at will, for they are restricted within certain limits depending upon structural and technical considerations connected with the firing, etc. In Europe generally a length of 11 metres and a height of 3.5 metres have not been exceeded hitherto. In America, where it is customary and necessary to do things on a larger scale, the dimensions of the coking chamber have reached 13.4 m. in length and a round 4 m. in height.

The width of the chamber has the greatest influence upon the coking capacity of the oven. It influences directly the coking time, which is increasingly curtailed as the width of the chamber is reduced. The coking capacity of the oven, in respect of a like period, increased correspondingly. This increase does not, as one would at first suppose, occur at the same rate as the curtailment of the heat path effected by reducing the width of the chamber, but more rapidly. Efforts have already been made to derive a formula of relationship between width of chamber and carboniz-

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*Iron and Coal Trades Review, London, England.
†Essen, Germany.

ing period. Thus Rühl*, taking as basis the simple law of the flow of heat.

$$Q = \frac{\lambda}{s} \cdot (t_1 - t_2)$$

finds that, assuming the wall temperatures to be equal, the carbonizing periods of two chambers of different widths are in the same ratio as the products of chamber width and mean heat path. By this he understands the sum of the thickness of the walls and ¼ the chamber width. In the arbitrary assumption of such mean heat path he may no doubt have been influenced by the consciousness that, as is indeed the case, the heat processes in the chamber are more subject to the laws of heat storage than to those of the simple flow of heat. The processes are, however, still further complicated by the temperatures in the coal mass, which are continually changing in regard to location as well as time during the carbonizing period, and by the constant change in the chemical and physical nature of the contents of the chamber as the heat passes to the coal core. Accordingly, it appears scarcely worth while to establish a ratio between width of chamber and carbonizing period by way of theoretic calculation. Moreover, Rühl's figures agree only approximately with practical results. Accroding to his calculation, for example, with chambers 350 mm. wide the coking time would be 66.5 per cent of the coking time with 450 mm. chambers. In practical working, however, it was found that the coking time with chambers 350 mm. wide is only about 57 per cent of that with chambers 450 mm. wide.

Now, what influence has the chamber width on the coking capacity of the plant? To examine this problem, let us compare two plants with the same extent of site, the same external dimensions, but chambers differing in width and therefore in number. Then to enable a judgment to be formed as to the economic influence of the chamber width, it is important to establish what capacity can be accommodated in both cases on the same site and with the same plant-dimensions.

Let these be indicated by:

b_1 b_2 — Width of chamber.
d — Width of heating wall plus twice thickness of wall.
k_1 k_2 — Number of chambers.
B — Length of battery.
L_1 L_2 — Plant capacity in 24 hours.
z_1 z_2 — Carbonizing period.

Then:

$$B = k_1 (d + b_1) + d = k_2 (d + b_2) + d.$$

From which

$$\frac{k_2}{k_1} = \frac{d + b_1}{d + b_2} \qquad (1)$$

The coking capacity of the plant is:

$$L_1 = k_1 : \frac{24}{z_2} \cdot b_1 \cdot n$$

or

$$L_2 = k_2 \cdot \frac{24}{z_2} \cdot b_2 \cdot n$$

In these equations n is a constant factor depending upon the dimensions premised as being identical in both cases: height of chamber, length of chamber and specific gravity of the coal. Further it is seen that:

$$\frac{L_2}{L_1} = \frac{k_2}{k_1} \cdot \frac{b_2}{b_1} \cdot \frac{z_1}{z_2}$$

and with the use of equation 1:

$$\frac{L_2}{L_1} = \frac{d + b_1}{d + b_2} : \frac{b_2}{b_1} : \frac{z_1}{z_2} \qquad (2)$$

In this expression d has a minimum width of 500 mm. The maximum width of chamber may be assumed as 500 mm., the minimum as 350 mm. Thus there results the equation:

$$\frac{d + b_1}{d + b_2} \cdot \frac{b_2}{b_1} = \frac{1000 \cdot 350}{850 : 500} = 0.822$$

The reduction of the useful chamber capacity of a plant due to diminution in the chamber width will accordingly result in a reduction of its coking capacity. The influence of the carbonizing period is indicated by the quotient $\frac{z_1}{z_2}$. The gross carbonizing

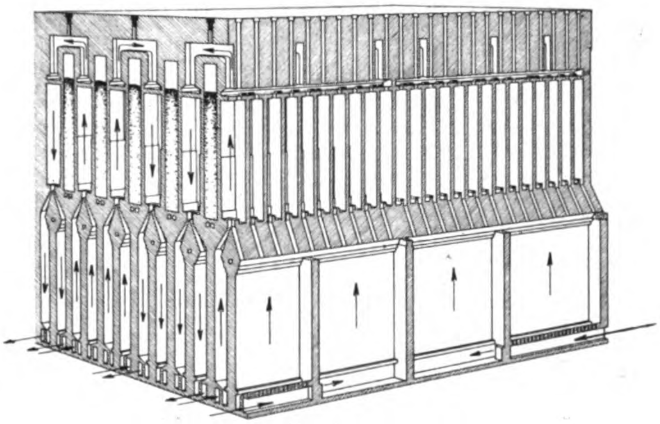

FIG. 3

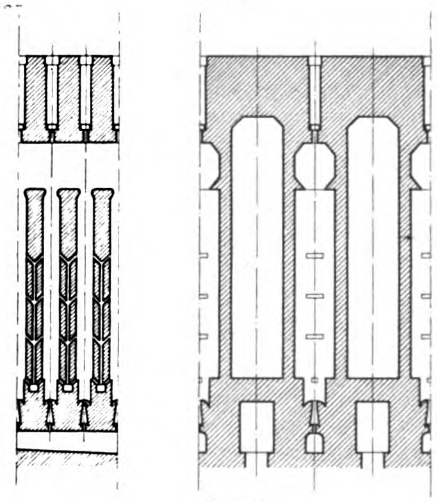

FIG. 4

FIG. 3—*Becker's improved type of Kopper's coke oven.*
FIG. 4—*Section through the Still oven with combustion in stages.*

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*Ruhl. "Relation between width of chamber and carbonizing period of the coke oven." Gluckauf, year 1922, page 1090.

period is longer by the time required for pushing and charging the chambers and is 24 and 12 hours respectively. Then

$$\frac{z_1}{z_2} = \frac{24}{12} = 2$$

Accordingly, the influence of the carbonizing period is extremely great. The total result is an increase in coking capacity:

$$\frac{L_2}{L_1} = 1,644$$

I.e.: On a given site with the use of chambers 350 mm. in width a 64 per cent higher coking capacity can be accommodated than in a plant with chambers 500 mm. wide.

From this, the great economic advantage of using narrow chambers is at once obvious.

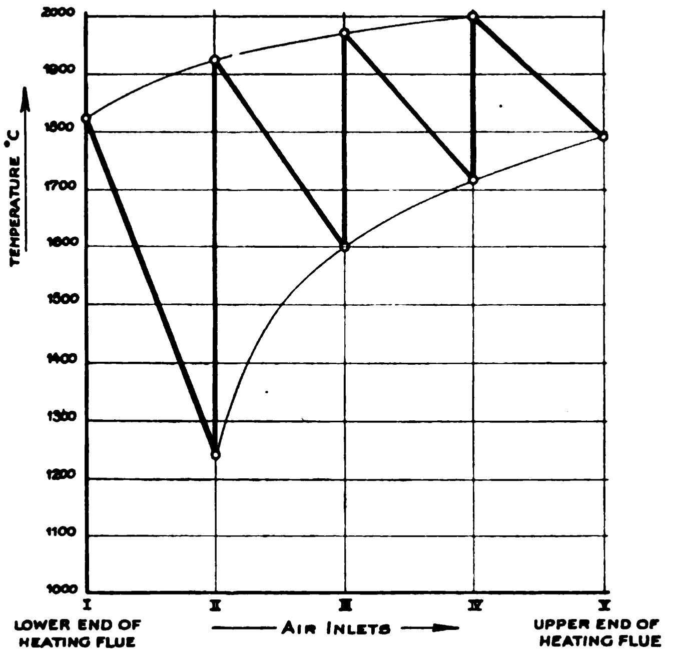

FIG. 5—*Theoretical temperature curve with stage-wise combustion in heating flue of the Still oven.*

The first coke ovens in Europe with chambers 350 mm. in width were erected in 1914 at the Berlin Gas Works, Danzigerstrasse, by the Koppers firm of Essen. The selection of such narrow chambers, which at that time were not yet customary, for this plant, was made with the definite aim of accommodating a large capacity plant on a small available site. Thus, even at that time, the fact had been recognized that the problem of obtaining the maximum capacity on a small site was only to be solved by using narrow chambers. In the European coking industry, the narrow oven was not introduced until 1921, when one was erected, as an experiment at first, at the Bahnschacht Coke Works of the Prince of Pless Mining Administration at Waldenburg, in Silesia* (Fig. 1). In the United States of America, the first trial plant of 24 Roberts regenerative coke ovens with chambers 355 mm. in width was erected by Roberts, at Dover (Ohio) in 1916.

It is to the decisive influence of the chamber width on the coking capacity that the narrow chamber primarily owes its economic superiority over all wide coke ovens of whatever type; for, compared with this advantage, the differences in type are less remarkable in their economic results.

The width of chamber also influences to a certain extent the nature of the coke, although it is already substantially determined by the coal used. The more recent observations and research in connection with coke have proved this fact, and have also furnished the explanation in this direction. Ever since Koppers revived the question of the combustibility of coke*, a number of investigators and research institutions have been trying to find the explanation of the properties of coke and other coked fuels by way of laboratory experiment and tests. Much tedious and delicate work has been performed in this connection by all concerned. One of the most valuable works is that of Dr. Rösli, because it gives a complete survey of all the facts hitherto established, and supplements this information by a new and highly promising method for determining the reaction capacity of fuels and by new discoveries†. In this work he comes to the conclusion that the reaction capacity of coked fuel against streaming air, carbonic acid and steam runs parallel with and is dependent upon the degree of distillation, the production temperature and very largey on the nature of the surface.

At an earlier date, Sutcliffe and E. C. Evans, Bunte and others‡ had already found that surface development exercises a strong influence upon the reaction capacity. From this its dependence also upon the width of chamber may readily be deducted. With a greater width of chamber the path of the distillation gases flowing to the chamber wall is prolonged. Since the coking speed is simultaneously reduced, the speed of flow of the gases is also retarded, and they remain in contact with the red hot coke for a longer time and on a longer path.

Consequently the wider the chambers, the larger the extent to which gas decomposition and carbon deposit, with thickening of the cell walls of the coke surface, occur. This phenomenon is further intensified by the generally higher temperature of the chamber wall in wide chambers and of the coke layers resting against this wall. In coke from wide chambers, therefore, we find graphitic deposits on a larger scale on the cell walls, which deposits partly choke up the cells: certainly they thicken the texture and so cause a certain degree of reaction inertia. Thus, for the purpose of producing a homogeneous, easily combustible coke for blast furnaces and domestic use the narrow chamber is more advantageous.

(To be continued.)

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*Koppers: "Some remarks concerning Blast Furnace Coke", Stahl und Eisen, 1914, p. 585. Koppers: "Progress in the matter of coke production, the influence of the quality of the coke on blast furnace operation and suggestions for improving the latter", Stahl und Eisen, 1921, pp. 1173 and 1254.

†Dr. Rosli: "Studies relating to the Distillation and Reaction Capacity of Coked Fuels," Monthly Bulletin of the Swiss Association of Gas and Water Experts, year 1924 (obtainable as a reprint from the Swiss Association).

‡Sutcliffe and E. C. Evans: "The Influence of the Texture on the combustibility and other properties of solid fuels", Transactions of the Society of Chemical Industry, 1922, June 30, pp. 196-208. Bunte and Fitz: "Concerning the causes of the varying reaction capacity of coke," Gas und Wasserfach, 1924, p. 241.

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By E. H. McCLELLAND*

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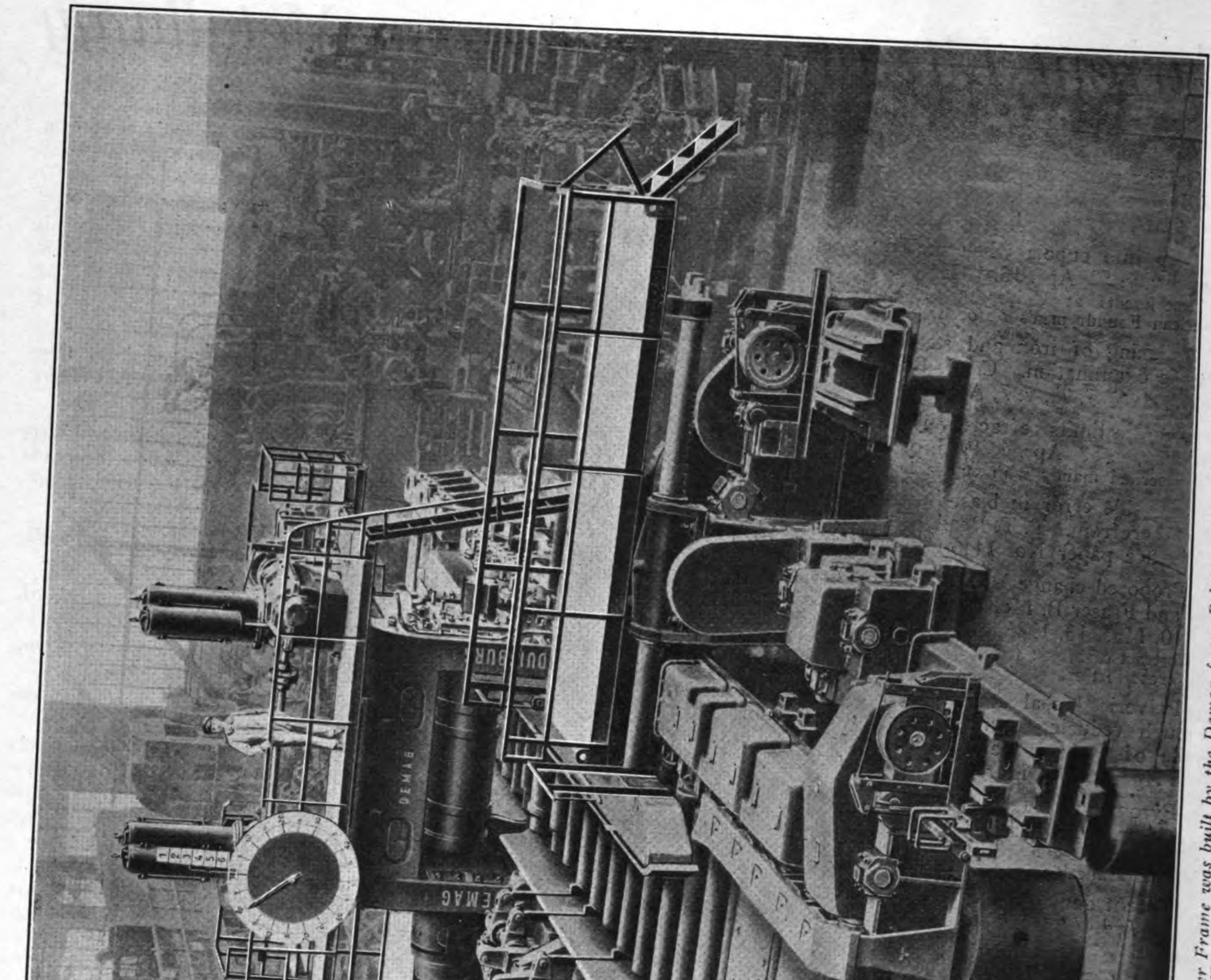
*Technology Librarian, Carnegie Library, Pittsburgh, Pa.



A NEW ROLLING TRAIN—*The Duo Reversible Block and Bar Roller Frame was built by the Demag for a Belgian mill. The capacity of the machine is 2,400 metric tons in 24 hours. The power generated by the motor is 15 to 18,000 hp. The total weight of the machine, including block shears and loading appliances is 1,800,000 kilos.*

Conservation of Scrap Iron and Steel*

Including Some Vital Tables Showing Growing Importance of Scrap

By G. E. EDDINS

IRON and steel scrap is a far more important factor in steel making than is generally realized. Reutilization of scrap is as old as the iron industry itself but the extensive use of it and organization of the scrap-collecting industry on a commercial basis began with the rapid development of the open-hearth process of manufacturing steel. In the early years of steel making some scrap was used in the Bessemer converter but later almost the entire supply was absorbed by the newer process. The industry has been organized on a national scale as we know it today only about 25 years. The war emphasized the necessity of scrap as a secondary source of raw material for the iron and steel industry. The emergency brought wider recognition not only in the United States but also in the steel-making countries of Europe of the fact that scrap is the steel industry's "second line of defense." The scrap business has grown from nothing to a position comparable to any of the basic raw material producing industries.

Prior to the beginning of the current year more than 855,000,000 tons of pig iron had been made in the United States. Of this, about 40 per cent was made within the last decade. Of the quantity of steel ingots and castings manufactured during the same period more than one-half was produced within the last 10 years. With the advance of the steel industry from year to year, scrap as a raw material becomes increasingly important. Theoretically every pound of metal is a potential source of scrap from the moment it goes into use. From a practical standpoint, however, much of it is irretrievably lost by oxidation in melting and from corrosion due to exposure to the air. The annual loss of all metals from corrosion is estimated at a value of about $200,000,000 to $300,000,000. Some iron and steel is irrecoverable on account of the uses to which it is put, but the greater part finds its way back to the furnace to be converted into a new form.

There is no way to determine definitely how long it takes for steel to return to scrap. It is obvious that the time required for steel to reenter the channels of raw materials depends largely on the use in which it was originally employed. Thus automobile steel may return to the scrap pile within a shorter time than steel rails. In general it is said that the duration of the life of steel under the stress and strain of modern industries is tending to decrease. As the amount of iron and steel in use has increased the tonnage that annually becomes useless for its original service necessarily grows from year to year. Consequently in recent years there has been a pronounced tendency for scrap to come on the market in larger volume. During the war necessity for supplying the sinews of war impelled conservation of waste material. This tendency was perhaps more outstanding in Europe than in America.

From a wartime emergency to peace-time economy conservation of scrap iron and steel has become the order of the day. In the best-managed industries conservation of all waste materials is now widely urged and increasingly practised as a potent means of cutting down cost and increasing profits. The industry that does not economize in operating cost by conserving its waste materials wherever possible usually finds itself at a disadvantage in this age of keen industrial competition.

There are in the United States approximately 3,000 scrap iron yards, involving the investment of millions of dollars, employing probably 50,000 workers and an additional 150,000 scrap collectors who depend on this occupation for a livelihood. Sources of scrap are as varied as the uses of iron and steel, although the greater part of it comes from a few well-defined sources. Ferrous scrap is derived from iron and steel rejected in process of manufacture and from old and disused products. All commercial scrap has to be sorted, prepared and properly graded before it can be used to advantage. The complexity of the industry is intensified by the existence of numerous classifications of scrap. (See Blast Furnace and Steel Plant, August, 1924.)

Except as to the use of scrap in the basic open-hearth process there is no satisfactory basis for even a guess as to the total quantity conserved. Some manufacturers owing furnaces utilize their own scrap materials. Others on account of limitations in the size of their business produce insufficient scrap of the desired classification to supply their needs. These sell their various grades through the scrap dealer who serves as a clearing house for waste materials, and in turn they purchase from the dealer the grade of scrap desired. It is the duty of the scrap dealer to sort down and classify the numerous receipts and supply the demand wherever needed with the grades and qualities desired.

About one-fourth of the scrap supply is derived from the railroads. About 35 to 40 per cent is industrial or "works scrap" produced in various iron and steel works and rejected in the process of manufacture. This is the most important source and scrap of this class has been conserved consistently by the industry. The remaining 35 per cent is derived from leaders' scrap iron yards. It consists of material purchased from railroads and industrial plants together with supplies gathered from urban and rural districts by collectors who ship it to the large dealers. Thus an essential part of our scrap supply is collected by the junkman whose chief interest is to dispose of his accumulation each day for cash so that he can carry on his trade the following day. The economic importance of scrap to the iron and steel industry has added a measure of respectability to the scrap-collecting business.

If we assume that the greater part of iron and steel used eventually returns to be remelted or converted into rolled products a general idea of the potential sources of scrap may be obtained from Table I which shows percentage distribution of steel consumed by various industries in 1922, 1923 and 1924 as compiled by the Iron Age.

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*Statistics furnished by National Bank of Commerce.

It cannot be assumed that the life of iron and steel will be the same in all industries or that the return flow from these industries to the channels of raw material will be in the same proportion as their consumption requirements. Duration of life and the amount of scrap actually available each year are the unknown qualities of the industry.

Industrial scrap or that produced in works and rejected in the manufacturing process may include every conceivable form from crop ends to ingots, billets and blooms to machine-shop turnings which ordinarily return to ingots within a brief time. Steel rails may be worn out within three to 50 years' service, depending on traffic, and automobile steel within 10 to 15 years. The average life of the automobile is now estimated to be around seven years but even so it is a long time before the component parts drift back as scrap. It is easily conceivable that steel going into structures such as the Equitable and Woolworth buildings may remain in service indefinitely.

TABLE I — DISTRIBUTION OF STEEL

Industries	1922	1923	1924
	(Percentage of total.)		
Railroads	22	27	28
Building and construction	15	15½	18
Automotive	10	11	9
Oil, gas, water and mining	10	10½	9
Export	7	6	6
Food containers	4	3½	4
Machinery	*	3	3½
Agriculture	4	4	3
All others	28	19½	19½
Total	100	100	100

*Included in "All others."

Much scrap never appears on the market, being utilized in the works where it is produced. Such scrap originating in steel mills and iron foundries in the forms of butts, crops, scale, ladle, pit, runner and foundry scrap amounts to several million tons annually and stays within the confines of the steel mills and iron foundries for remelting purposes. Considerable quantities of worn out cast-iron car wheels never appear on the market but are exchanged directly for new wheels. Many steel rails after having served a useful life on a trunk line are relegated to a new use on a less important line or, perhaps, afterward serve around mining or lumber camps or industrial plants before ultimately finding their way back through the scrap yard to the furnace.

Railroads consume 25 to 30 per cent of the total output of steel in this country. About 30 per cent of their steel requirements are steel rails. It is obvious that the amount of scrap available from steel rails at present depends largely on the extent of railroad building 20 or 30 years ago and on the policy of the railroads toward replacement.

To illustrate the potentialities of steel rails as a source of scrap, in the period of most active railroad construction in the United States more and more rails were used until a peak was reached in 1887. Rails produced in that year amounted to 2,140,000 tons. In the years following production of rails decreased and the record of 1887 was not duplicated until 1899 when 2,273,000 tons were produced. About the beginning of the twentieth century the introduction of heavier rolling stock necessitated replacing light rails with heavier sections and by 1906 production had increased to 3,978,000 tons, which so far has been the peak of annual output in this country. Production in 1924 was 2,433,000 tons.

An unusual situation arose in the transportation field as a result of high prices of scrap during the war. Several roads found it profitable to junk some of their trackage rather than to continue operations over it, the difference between the book value and the scrap value of the rails returning a handsome profit to the roads.

The transportation industry has made marked progress in adopting a uniform classification of its scrap. This greatly facilitates marketing and has been a further step in the general policy of conserving waste iron and steel. Railroads have been referred to as trustees of all ferrous material entering their equipment.

Among other important sources of railroad scrap are locomotives, freight cars, switches, signal systems and numerous classifications including axles, couplers, springs, car wheels, etc. Not all the equipment that has seen its first years of service is relegated immediately to the scrap pile. When the average life of a locomotive is placed at 25 years, it does not mean that its period of usefulness is necessarily ended. It may be retired from the railway system yielding its former position to an improved type such as the powerful Mikado. If a purchaser can be found obsolete locomotives are sold for service on short lines or in industries. Otherwise they are scrapped. In a similar manner freight cars, many of which are all steel in construction, having seen their best days of usefulness for heavy traffic, may be repaired and transferred to lighter service, and finally parts that are not worn out are used for replacement instead of going to the scrap pile. Naturally the life of railroad equipment depends on conditions under which it is used, wear and tear and the kind of treatment received, but ultimately everything goes back to steel ingots.

The amount of structural steel scrap available now is negligible. Structural shapes have been used in building construction scarcely 50 years. Steel used for this purpose is not ordinarily exposed to the elements and consequently lasts indefinitely. While this may be a potential source of scrap for the future nothing less than obsolescence will make appreciable amounts available for current supplies. Most of the shapes recovered at present from old buildings are sold by wreckers for further use in the building industry. Steel going into bridges is also long lived. but it ultimately becomes scrap.

It is apparent that as the country develops, more and more iron and steel will become tied up in its expanding industries. Much of it may serve in its original capacity of usefulness for a long period of years, remaining only a potential source of scrap. but in the course of time a steady stream of scrap from practically all sources will be released to flow back to the open hearth to acquire a new lease on life. The conclusion is that as the industry grows older the tendency for the quantity of available scrap to increase will continue.

Automotive industries consume about 10 per cent of the nation's steel output each year. The average life of an automobile is variously estimated at from five to seven years. Since 1903 about 24,000,000 cars and trucks have been produced by American companies in the United States and Canada. At the beginning of 1924 there were 17,592,000 cars and trucks registered in the United States. During the past 21 years exports of cars and trucks from the United States have exceeded imports by about a million. These figures indicate that about 5,000,000 cars remaining in the country have been discarded.

Few articles of steel finish their period of service as quickly as does the automobile, although its length of life is conceded to be increasing. The automobile industry promises to be a steady and important source of scrap. At present scrap from this source although of good quality is poorly prepared and there is much room for improving its preparation for the market.

Some other industries supplying certain quantities of scrap are oil, gas and mining industries, agricultural machinery and implements, discarded ships, food containers and other sources almost as numerous as the uses of steel itself. It is estimated that about 5,000,000 tons of country scrap comes on the market annually. This is derived from all sources other than railroads, industries and automobiles. Much of the scrap, however, that might be obtained from miscellaneous sources throughout the country is irrecoverably lost because cost of collecting it is prohibitive.

Use of Scrap.

The most universal process evolved for producing steel is the basic open-hearth process, which uses 80 to 90 per cent of the scrap iron and steel consumed. It is the general practice in this country to charge some scrap into all mixtures. Not only is a saving in cost effected but the quality of the steel is improved. About 50 per cent of the charge in the basic open-hearth process is scrap and as much as 100 per cent of scrap may be charged in an electric furnace. In 1920 when the price of basic pig iron was from $13 to $15 per ton higher than No. 1 steel scrap the proportion of scrap in the basic open-hearth process ran as high as 60 per cent of the total in a number of steel mills.

In times past there were frequent discussions as to whether the supply of scrap would continue to keep pace with the requirements for open-hearth steel production. Table II indicates the status of the relation of scrap consumption to basic steel and basic pig iron production from 1896 to 1924. The statistics given are to be construed liberally as to the proportion of scrap and pig iron used in manufacturing basic open-hearth steel, no account having been taken of loss in weight of either pig iron or scrap in the process of converting to steel.

In the early years of the industry when the output of basic pig iron and steel was but a fractional part of the present output the proportion of scrap used was 50 to 60 per cent of the total raw material going into basic open-hearth steel. The higher percentage of scrap used in the early years of the basic open-hearth process was due probably to relatively larger amounts of scrap available in comparison to the amount of basic steel produced.

The introduction of this process was really the big factor in making possible the conservation of scrap on a large scale. Since there was no extensive outlet for scrap iron prior to the widespread introduction of this method obviously there were relatively large accumulations of scrap which were conducive to its use in large proportions.

In the 10 years immediately preceding the war the percentage of scrap decreased from the high level of 55 to 60 per cent in the early years of the open-hearth industry to a low point of 38 per cent in 1909 and 1913. During the period between these years, however, there was an unprecedented expansion in the output of basic steel which indicates that it was inability to procure adequate supplies of scrap that led to a reduction at that time in the proportion used in manufacturing basic steel.

TABLE II — ESTIMATED PROPORTION OF SCRAP AND OF BASIC PIG IRON USED IN PRODUCTION OF BASIC OPEN-HEARTH STEEL

Year	Basic open-hearth steel gross tons	Basic pig iron per cent	Scrap per cent
1896	776,256	43	57
1897	1,056,043	53	47
1898	1,569,412	50	50
1899	2,080,426	47	53
1900	2,545,091	42	58
1901	3,618,993	40	60
1902	4,496,533	45	55
1903	4,734,913	43	57
1904	5,106,367	49	51
1905	7,815,728	53	47
1906	9,658,760	52	48
1907	10,279,315	52	48
1908	7,140,425	56	44
1909	13,417,472	62	38
1910	15,292,329	59	41
1911	14,685,932	58	42
1912	19,641,502	58	42
1913	20,344,626	62	38
1914	16,271,129	59	41
1915	22,308,725	59	41
1916	29,616,658	60	40
1917	32,087,507	55	45
1918	32,476,571	57	43
1919	25,719,312	56	44
1920	31,375,723	53	47
1921	15,082,564	51	49
1922	28,387,171	49	51
1923	34,665,021	57	43

In the years since the war there has been a tendency for the proportion of scrap used to increase. The coal strike of 1922 made pig iron hard to get

Scrap has no cost of production in the ordinary sense, being only waste incident to wear, replacement and industrial processes. Its value is what it will bring on the market and the current of incoming scrap runs counterwise to the current of outgoing finished steel products. Notwithstanding the fact that the great centers of steel production are in the East, practically 50 per cent of the scrap produced in this country comes from the area west of Chicago.

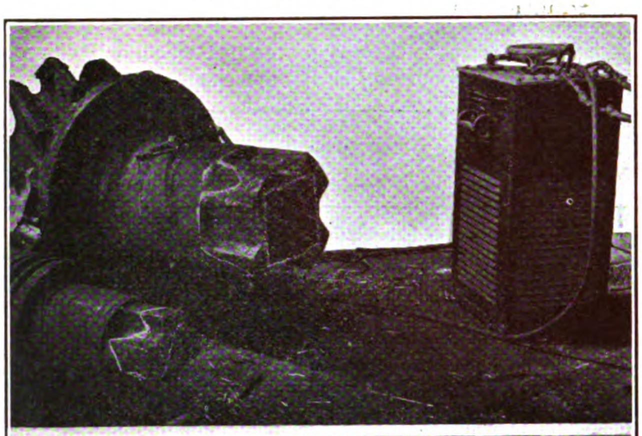
Conservation of waste materials in the iron and steel industry not only prevents unnecessary loss of our iron ore reserves but the otherwise waste materials add quality to the finished steel product and a full measure of profit for the producer. The futile effort of the ancient alchemist to turn base metals into gold in one sense has been accomplished in the development of the scrap iron business to a position in the steel industry second in economic importance only to ore and coal.

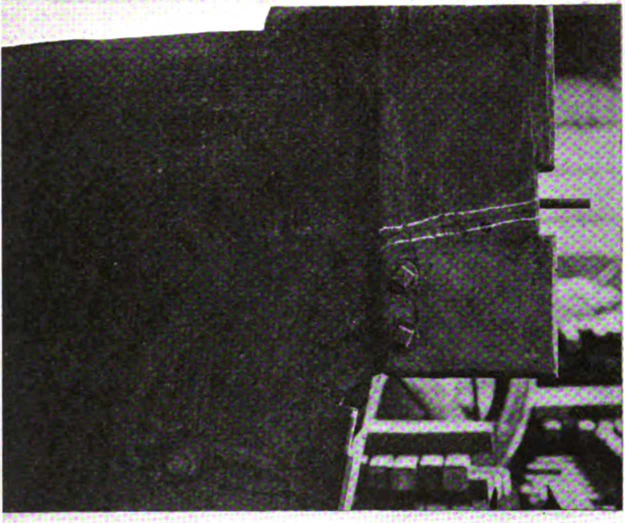
Arc-Welding in Steel Mills

A Great Variety of Uses Which Speed Repairs and Reduce Costs

By R. L. SCOLLARD*

TO the many readers who are familiar with this kind of work, this article will be of no special benefit, but for each one that really knows the great value of an arc welder in the mill, there are without a doubt hundreds that have either failed to learn the facts regarding this process or are skeptics.





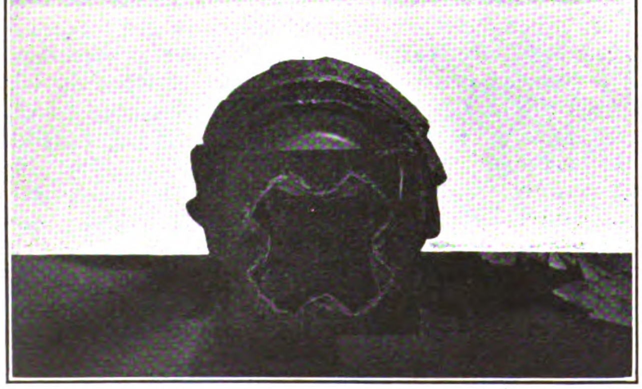


FIG. 1—*Shows a 36-in. pinion with badly worn wobblers.*
FIG. 2—*A makeshift repair—plates bolted on cracked housing.*
FIG. 3—*The template placed over pinion end visualizes the badly worn spots.*

It is, of course, to these latter that I will attempt to prove conclusively that the mill today which is without an arc welder is sadly handicapped in the matter of speedy repairs in an emergency. Further, they are likely to have an exceedingly large overhead because of continuous purchases of new equipment to replace that broken, or worn out, which in the majority of instances could be quickly and cheaply reclaimed.

To attempt to list all parts that can be and are being reclaimed would take considerable space, but a few of the principle ones are: Roll and shear housings, worn and broken wobblers on rolls and pinions, pumps, replacement of broken pinion gears, rebuilding of armature shafts, repairing of broken rest bars, building up and lengthening of mill screws, mill saddles and locomotive firebox patches both inset and applique, together with the welding of leaky boiler tubes. In short, nearly everything from a worn air hammer trigger to the largest millhousings and alligator shear jaws.

The illustrations herewith will give a close insight as to the necessity as well as the great value of the arc welder in the steel mill, regardless of how large or how small that mill may be.

No. 1 is a 36-in. pinion. The wobblers were worn nearly completely off. The area within the chalked lines indicates the extent of wear and necessarily the amount of new metal added. This had been scrapped and was about to be shipped as such when salvaged. Fifty hours of labor plus 150 lb. of wire renewed this to its original condition and value of approximately $2,000.

Alongside this is to be seen a 14-in. roll that had broken wobblers. Ten hours' labor and thirty pounds of wire renewed this to its original condition and value of approximately $900.

No. 2 shows the method of bolting plates to a cracked housing. This is a costly makeshift which is practiced in many mills but is not a satisfactory repair and is constantly demanding attention, because of the loosening caused by the vibration of the machine. Twenty-four hours' labor and 60 to 70 lbs. of wire will make this a permanent job.

Heavy duty shears which have been discarded because of a large crack have been restored to service at a cost of 60 to 70 lbs. of wire plus 24 hours of labor.

Nos. 4, 5, and 6, show methods and results of arc welding which should be most enlightening to those not familiar with the process and most convincing to those that are skeptical. The studding is not necessary on steel casting. This hammer as everyone knows is of cast iron. This weld was applied over two years ago and no defects have appeared to date.

No. 3 is opposite end of 36-in. pinion. A template has been placed over wobbler end, showing the worn area. A few hours' labor will renew this wobbler end and save additional expense by eliminating wear and gear on boxes, and damage to motors, by eliminating the unequal strain produced by sudden shocks due to excessive lost motion.

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These conditions are typical in every mill, and in view of the enormous saving in both time and money in overcoming these problems it is illogical for the plant officials to continue with obsolete shop practices when conclusive proof of the benefits to be had from the use of arc welding can be seen and are to be had for the asking.

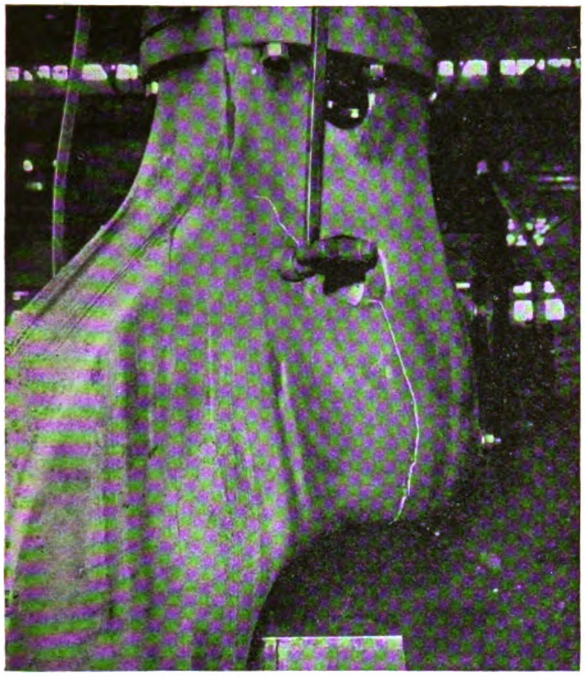

FIG. 4—*Example of a badly cracked hammer.*

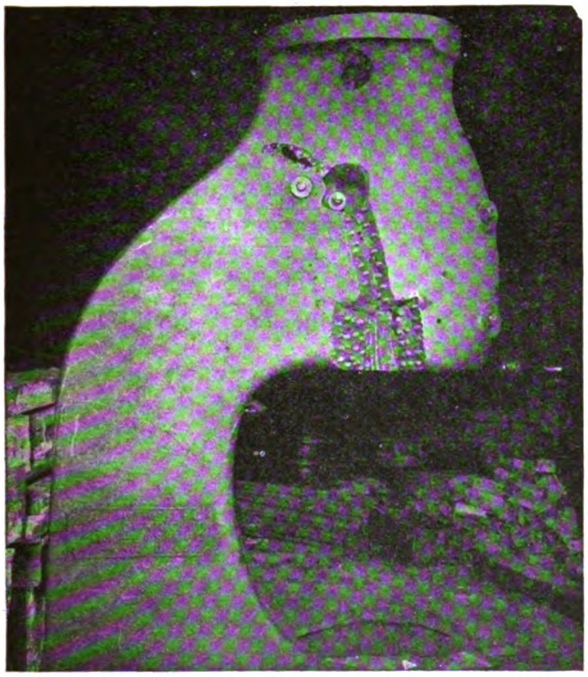

FIG. 5—*Note the studs used in the repair, these are unnecessary.*

There was a recent emergency when a guide on a main water pump broke and caused a shut-down of only 35 minutes. Ordinarily this would have taken several hours to repair but after 25 minutes of drilling and studding and 10 minutes of welding this pump was again in operation.

The saving on this one job, not counting the value of the pump itself, but considering the loss of production in the mill for several hours, which was averted by the use of the welder, was many times the cost of a welding outfit.

It used to be a fact that large stationary motor generator arc welding sets alone were available for reclamation work. This materially cut down the more general use of welding because of the serious difficulty of getting either the heavy welding outfit to the work or vice-versa.

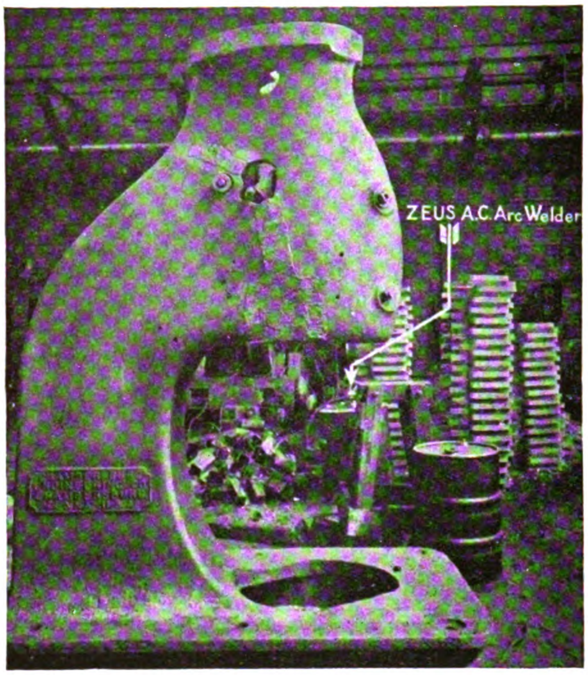

FIG. 6—The completed weld, good for several years' service.

It is now possible to obtain machines which can be easily carried to any part of the mill by two men.

British Research Committee Reports on Steels for Cutting Tools

(Continued from page 289)

Results having been advanced to indicate that the vertical force of a compact shaving of a given depth of cut and traverse remains practically constant at all speeds, it was thought that a certain percentage increase of the initial force would afford a suitable measure of durability, and for the purpose of measuring the cutting force while cutting progressed a special dynamometer was designed and fitted to the turret of an ordinary No. 4 Herbert combination lathe. With such extremely light cuts the force for a given cut was found not to remain quite constant at all speeds, but by adopting a percentage increase of the initial force this small variation did not appreciably affect the standard. With a 15 per cent increase the cutting edge of the tool was seriously injured, while with a 5 per cent increase it was unimpaired. A 10 per cent increase corresponded with the stage at which the operator sought to withdraw the tool for regrinding, and was taken as the measure of durability. The 10 per cent increase in the initial vertical force corresponded approximately to a 15/10,000 in. wear of cutting edge, and bore a distinct relation to the breakdown point of the tool.

The POWER PLANT

Expansion Steam Bends

Conclusion of Series of Formulae Suitable for High Super-Heats

By **P. M. GALLO,*** M.E.

PART III

WHEN it is desired to eliminate bending from all flanges in an expansion bend, it can be done if the size of pipe and bend admit of the construction shown in Fig. 8.

When it is desired to eliminate bending from all flanges in an expansion bend, it can be done if the size of pipe and bend admit of the construction shown in Fig. 8.

In any bend, if the tangent or straight ends where it connects to the line are made 10 to 20 pipe diameters, the bending on the flange will be considerably reduced. The longer these tangent parts the less the bending, being somewhat fixed if there are any lateral supports near the bend.

Bend, Fig. 8, is the ideal expansion bend It is self contained; that is, none of the internal stresses in the bend caused by the expansion are transmitted to the line embracing it All other bends shown impose a lateral force on the line embracing them.

When the bend contains straight pipe in its vertical legs, as per Fig. 9, then consider this straight pipe of length "l_e" as a beam fixed at one end, guided at the other end, loaded at the guided end Let the deflection be "M" of this beam, and the horizontal component of M = "N" when the straight part is not vertical Then the expansion of the double offset is figured by Eq. 2 or Eq. 6 = F. The total expansion then is F + 2N. When the straight part is vertical then "N" becomes "M". The force P is figured by Eq. 1 or Eq. 5, considering the points "a" as points of inflection when the two curves are tangent as in Fig. 1. The introduction of the straight pipe shift the point of inflection $\frac{l_e}{2}$ to point b.

This covers practically all types of bends that occur in practice.

Take a 10-in. steam line, 200 ft. long between anchors.

Steam pressure: 200 lb. gage.
Superheat, 100 deg. F.
Pipe: 10 in. by ⅜ in. thick, O. D. 10¾ in.

Determine double offset expansion, standard type, all radii equal, throat or neck equal to half radius. Assume minimum temperature zero deg., which is the case if line were shut down on a cold day when the plant is not working. The maximum bending stress is not to exceed 20,000 lbs. per sq. in.

Temperature at 200 lb. pressure	388° F.
Superheat	100° F.
Total temperature range...	488° F.
Expansion per 100 ft..........	4.55"
Expansion for 200 ft..........	9.10"

Assuming the expansion bend to be spread as much as it contracts, then figure 4.55 in. that the bend must take up one way.

Therefore: $F = 4.55''$
$E = 29 \times 10^6$
$d = 10.75''$
$S = 20{,}000$

By Equation 8:

$$R = \sqrt{\frac{FEd}{19.731S}} = \sqrt{\frac{4.55 \times 29 \times 10^6 10.75}{19.731 \times 20{,}000}}$$

$$= 59.96 \text{ in, say 5 ft. 0 in. Radius}$$

I, for 10 in. x ⅜ in. pipe, is 172.5

Then by Eq. 5:

$$P = \frac{FEI}{9.8655R^3} = \frac{4.55 \times 29 \times 10^6 \times 172.5}{9.8655 \times 60^3} = 10{,}680 \text{ lbs.}$$

For an extra heavy pipe ,10 in x ½ in. thick, of which I = 212, the value of P would be $\frac{212}{172.5} \times$ 10,680 = 13,100 lb. The anchors must be rigid enough to resist this force, P, otherwise the bend will not take the expansion allotted it.

The bursting stress per sq. in., $S_k = \frac{200 \times 10}{.75} =$ 2667.

This acts at 90 deg. with the bending stress; by Eq. 17.

The logitudinal stress due to the steam pressure is $S_b = \frac{78.54 \times 200}{12.223} = 1285$ lb. per sq. in. by Eq. 16.

Then the total maximum stress is, by Eq. 18:

$$S_m = \sqrt{(S+S_b)^2 + S_k^2}$$

$$= \sqrt{(20{,}000+1{,}285)^2 + 2{,}667^2} = 21{,}451 \text{ lb. per sq. in.}$$

Assume a flanged joint of the Van Stone type were placed at the crown of the bend.

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*Pittsburgh, Pa.

A 10-in., 250-lb. flange has 16 1-in. bolts on a 15¼-bolt circle, the flange being set so that holes straddle the center lines as shown in Fig. 7.

The dimensions of a short lap are: $D = 12\frac{3}{4}$ in, and "D1", the inside of the pipe, is 10 in.

Then by Eq. F1:

$$X = .2946\,\frac{12.75^4 - 10^4}{12.75^3 - 10^3} = 4.512 \text{ in.}$$

By Eq. F2:

$$-P_b = \frac{172.5 \times 20{,}000}{4.512 \times 20{,}000} = 71{,}130 \text{ lb.}$$

By Eq. F3:

$$S_u = \frac{71{,}130}{16} = -4{,}450 \text{ lbs. per bolt tension}$$

For the above flange, $a = 1.487$; $b = 4.236$; $c = 6.34$; $d = 7.479$. Then $I_b = 232.565$. Fig. 7 shows a 10-in. flange.

By Eq. F4 the resisting moment of the bolts is:

$$R_m = \frac{2S_e}{d}\,232.565 = S_e\,\frac{465.13}{7.479} = -71{,}130 \times 4{,}512$$

$$S_e = \frac{-7.479 \times 71{,}130 \times 4.512}{465.13} = -5{,}161 \text{ lbs. on}$$

bolts (1)-(1) and + 5161 on bolts (8)-(8), Fig. 7.

By Eq. F7:

$$S_s = \frac{200 \times \pi \times 10^2}{4 \times 16} = -982 \text{ lbs. per bolt.}$$

Total stress or tension load on bolts (1)-(1):

S_u = — 4,450 lb.
S_e = — 5,161 lb.
S_s = — 982 lb.

—10,593 lb. total tension load on one bolt
— 2,118 lb. 20 per cent added equals tension to which bolt is tightened.
—12,711 = Tension to which bolt must be tightened to provent leakage when joint is under bending stress.

For bolts (8)-(8), Fig. 7:

S_u = — 4,450 lb.
S_e = + 5,161 lb.
S_s = — 982 lb.
— 2,118 lb. 20 per cent added as above.

— 2,389 lb. actual tension on bolts

Since a 1-in. bolt at 10,000 lb. stress per sq. in. at root of thread is good for only 5,180 lb. they would be too small. But if the bolt steel has the same or better properties than the pipe steel, then it would be permissible to work the bolts at the same fibre stress of 21,450 lb. and the bolt would be good for 10,700 lb. which is still a little short of what is required. The actual stress is $\frac{12{,}711}{.52}$ = 23,400 lb. per sq. in. This is too small a factor of safety, depending on only two bolts, and should one of these fail, the whole joint would simultaneously fail. Therefore, such joints should have larger bolts, or bolts of nickel, crome or vanadium steel of a tensile strength of 100,000 lbs. per sq. in., and an elastic limit of 60,000 lbs. per sq. in.

In the cast of welded or screwed flanges the results are much greater in value than for the Van Stone joint and need not be considered.

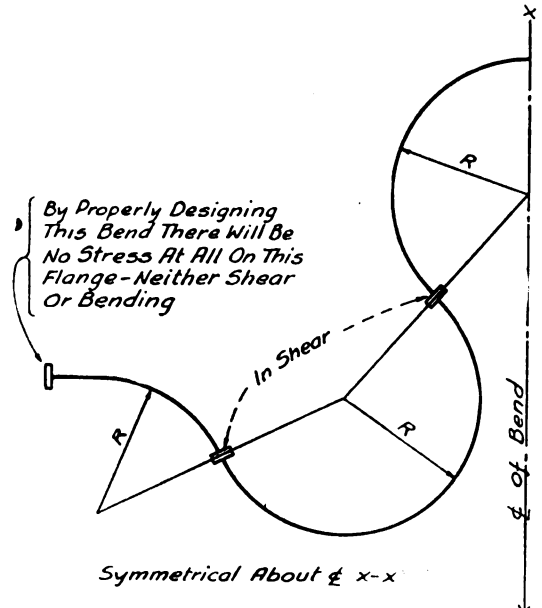

x
By Properly Designing This Bend There Will Be No Stress At All On This Flange - Neither Shear Or Bending
In Shear
R
R
R
℄ of Bend
Symmetrical About ℄ x-x
x

Fig. 8

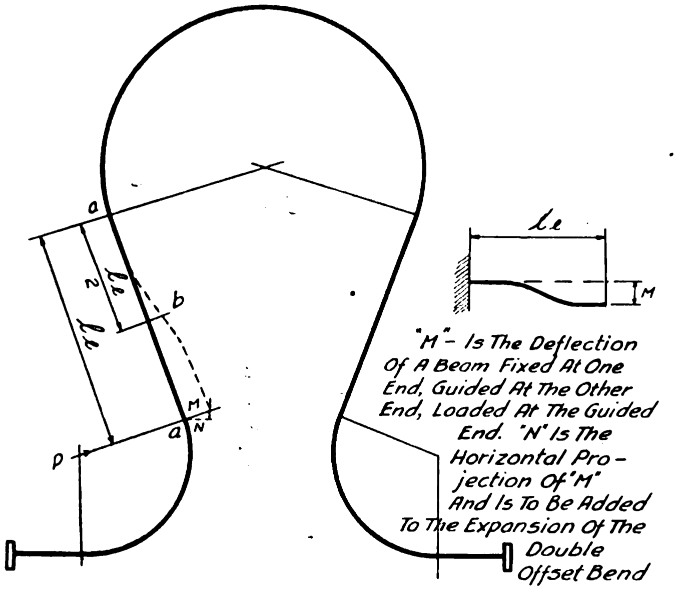

a
2
L₁
L₁
b
M
N
a
p
L₁
M
"M" - Is The Deflection Of A Beam Fixed At One End, Guided At The Other End, Loaded At The Guided End. "N" Is The Horizontal Projection Of "M" And Is To Be Added To The Expansion Of The Double Offset Bend

Fig 9

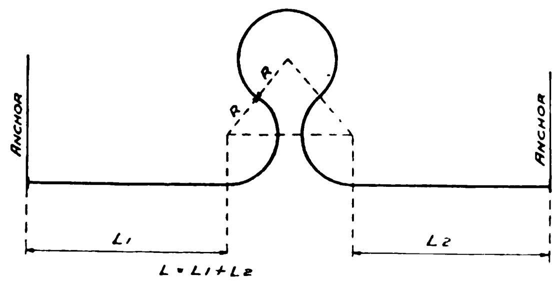


Fig. 10

FIGS. 8, 9, 10.—*An assembly of different radii steam bends.*

As for placing the joint at the points of inflection the calculation is much simpler and should be made only with male and female flanges whether Van Stone, screwed, or welded.

If each bolt were tightened up to a tension of 5,000 lbs., then the total force on the joint is 16 × 5,000 = 80,000 lbs Allowing a coefficient of friction of .25 then for a factor of safety of two, the shearing force should not exceed $\frac{80{,}000}{8} = 10{,}000$ lbs. Take actual value of P = 10,680 lbs. as previously determined. This apparently seems safe, but the flange pressure of 80,000 lbs. and the coefficient of .25 are very problematical, they may be attained, exceeded or be very much less. With a male and female joint this uncertainty is eliminated.

Note: Where the bend connects to the line, the lateral flexibility of the line evidently reduces the bending stress in the flanges at this point, the exact amount is indeterminate, depending on existing condition after the line is placed. But whatever reduction of this stress is, the stress at the crown point of the bend will be correspondingly increased

Since the minimum temperature in this climate to be used in calculating expansion bends is zero, and the pipe is always cut and coupled at a higher temperature, the amount the bend must be expanded in coupling it, depends on the atmospheric temperature at the time To find the amount the bend is expanded proceed as follows:

Let O = minimum temperature, deg. F.

Let t_m = maximum or working temp, deg F..

Let F_x = total amount bend must be expanded, ins.

Let t_x = atmospheric temp., of cutting and coupling the bend, deg. F.

Then:

$$F_x = \frac{2t_x - t_m}{2t_m} 2F \qquad \text{Eq. 16.}$$

When the value of F_x is negative the bend must be expanded when coupling, and the line therefore must be cut short by the amount of F_x.

When the value of F_x is positive then the bend must be compressed and the line therefore cut long by the amount of F_x.

Example: Let $t_m = 300°$F., 2F = 4 ins., $t_x = 100°$F.

Then $F_x = \frac{200 - 300}{600} \times 4 = -2/3$ in. the bend must be expanded since the value af is negative, being —2/3 in.

When calculating refrigerating piping the value of F_x will always be positive, and the bend must be compressed to couple it

In figuring the actual properties of bend required the elasticity of the straight pipe in the line in which the bend is coupled must be considered. This deformation is usually small compared with that of the expansion bend, but has a proportionate effect in decreasing the unit fibre stress in the expansion bend.

Note Fig. ( ).

L = length of straight pipe, ins, transmitting the bend reaction to the anchors, the whole being elastic it takes part in caring for the expansion and contraction

Let F_1 = extension or compression of "L" by force P, ins.,

F_t = total expansion the line will care for, in way, inches.

a = area of metal in cross section of pipe, sq in.

$$\text{Then } F_t = F_1 + F \qquad \text{Eq. F17.}$$

$$F_1 = \frac{PL}{aE} \qquad \text{Eq. F18.}$$

$$F_t = \frac{P1R^2}{EI} + \frac{PL}{aE} = \frac{P}{E}\left(\frac{1R^2}{I} + \frac{L}{a}\right)$$

$$= \frac{2IS}{dRE}\left(\frac{1R^2}{I} + \frac{L}{a}\right) \qquad \text{Eq. F19.}$$

$$P = \frac{F_t E}{\left(\frac{1R^2}{I} + \frac{L}{a}\right)}$$

$$S = \frac{d\,R\,E\,F_t}{2I\left(\frac{1R^2}{I} + \frac{L}{a}\right)} = \frac{d\,R\,E\,F_t}{2\left(1R^2 + \frac{LI}{a}\right)} \qquad \text{Eq. F20.}$$

By expanding in coupling it in line total expansion cared for is 2 F_t.

The value of "S" is the maximum unit fibre stress in the expansion bend only.

If S_p = unit stress in the pipe L, then $S_p = \frac{P}{a}$ Eq. F21.

This is always less than "S" and need not be considered unless the line "L" is to be investigated as a column.

In bends it is important that the seam of the pipe is 15° from the plane of bending on the tension side. This gives a minimum force to cause stripping or opening of the seam of the pipe.

Faccioli to Make European Tour

Guiseppe Faccioli, engineer of the Pittsfield plant of the General Electric Company, sails June 6 on the S. S. "Paris" for an extended European trip. Mr. Faccioli is taking his automobile and chauffeur with him and will travel by motor.

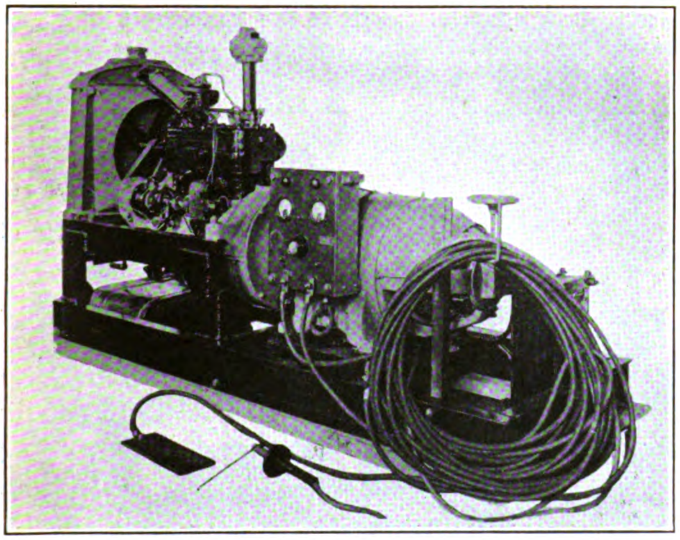
From Havre he will motor to Paris, where he will attend the third International Conference on High Voltage Systems. After visiting the various cities of France he will go to Berlin, and during July he will visit the principal cities of Germany, Austria and Czecho-Slovakia. Following a trip to Milan, Italy, where he will visit the General Electric plant in that city, he will visit relatives and friends in that country, his itinerary including Florence, Assisi, Rome and other cities. He will return to the United States on the S. S. "Conte Verde", sailing from Naples August 21.

WITH THE EQUIPMENT MANUFACTURERS

Automatic Arc Welding Equipments

Following several years of development and trial, the General Electric Company is now marketing a line of automatic arc welding equipments. These equipments, sold either as complete units or as separate parts, have been especially designed for quick, efficient and economical welding where quantity production is a factor. Heretofore, it has been the custom to supply the separate parts only.

The new oufit is expected to find its principal application in the construction of such standard products as tanks, boilers, cans, axle housings, and pipe, and also for repairing undercut shafts or axles and building up sharp flanges on car wheels. Its field of greatest usefulness will be in the manufacture of storage vessels where the static load is not greater than 10 pounds per square inch and where the thickness of the metal to be welded is not less than No. 16 gauge.



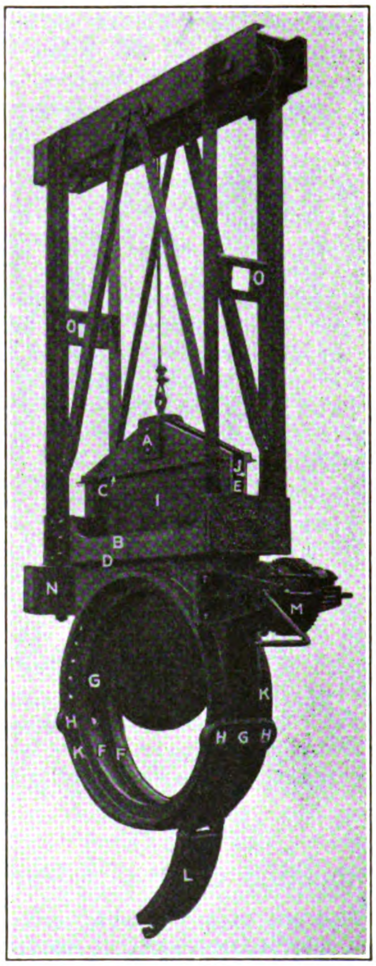
Outstanding among the advantages claimed for these automatic equipments is the resulting increase in speed of production following their installation. Estimates by General Electric engineers, based on actual production, show that this increase in speed is especially marked when comparison is made between the automatic arc welder and either hand arc welding or hand gas welding. A complete outfit can be operated by a man and helper, while the completion of an equal amount of hand work in the same time would necessitate the use of four or more men. Estimates also indicate a lower overhead expence than with gas welding, excluding the item of labor. The use of pushbutton control provides simplicity and ease in operation. Uniformity of finished product and space saving by the reduction of the number of workers and quantity of stock on hand are among the other advantages claimed for this equipment.

A complete outfit consists of an automatic welding head and control panel, travel carriage and clamping device. Where it is desired, in order to meet special circumstances in any plant, the travel carriage and other component parts of the equipment may be assembled by the purchaser with his own device for holding the work.

A list of products in the manufacture of which this automatic equipment is recommended includes ice cream cans; gasoline storage tanks; oil switch tanks; transformer tanks; range boilers; and pipe for dredging, oil well casings and irrigation purposes, and texile machinery parts. Automatic equipments are also recommended for repairing worn car wheel flanges, locomotive guide rods and worn axles and shafts. Several successful installations have been made by street railway companies both in the United States and foreign countries.

Vertical Sand Damper

The Mayers Vertical Sand Damper was born of necessity to meet the demand for a valve suitable for use on horizontal hot gas ducts, and this is the only vertical cutoff valve, or sand damper, to meet the requirements and receive the general approval of qualified engineers as well as practical producer operators.



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Operated by one man, it cuts off gas as soon as damper is in place and the space between the two valve plates filled with sand which also closes any small leaks. After the joints between the plates and seats have become tarred to insure tightness, sand may be removed to allow ventilation between the two plates for cooling purposes.

All danger of gassing men entirely eliminated. The sand damper is manufactured by the H. L. Dixon Company of Pittsburgh.

New Portable Acetylene Generator

A small generator for producing acetylene at low pressure for welding and cutting has recently been developed by the Oxweld Acetyene Company, 30 East 42nd Street, New York. This supplements a line of larger generators, a great many of which are used to supply pipe lines in shops where much cutting and welding is done.

The new generator, which takes 35 lbs. of carbide at one charge, can be transported readily from place to place, thus providing a portable supply of generated acetylene gas. Empty, the generator weighs only 210 lbs.

An entirely new principle of feed control is used which might be called a "heavier-than-water" float. A vertical partition, extending nearly to the bottom into a water seal, divides the generator shell. One side is gas tight and contains the carbide hopper at the top. The upper part of the other side contains gas regulating and protective devices, and an automatic carbide feed control. Generation of the first acetylene causes water to rise on this side of the partition high enough to all but submerge a pan full of water, hung to a control lever. This pan normally acts as a weight acting counter to a spring, but as the water rises about it, its apparent weight is diminished and the carbide hopper valve is closed by the action of the spring. As acetylene is drawn off, water rises in the gas compartment and correspondingly lowers under the float, relieves some of the buoyancy under the water pan, which, gathering weight with the receding water, depresses the spring and allows a small amount of carbide to drop into the generator, and restore equilibrium conditions.

Because of its low center of gravity, the generator rights itself when tilted at an angle of 30 deg. It works perfectly at an inclination of upwards of 10 deg. No adverse effects result if a generator while in operation is knocked over. Nearly all fittings are enclosed in the cylindrical shell and there is little, if anything, projecting which may be injured by a fall on a concrete pavement.

This generator has been submitted to the Underwriters' Laboratories, Inc., and has been listed by them as an acceptable device for installation on insured premises.

Combustion Control Advances

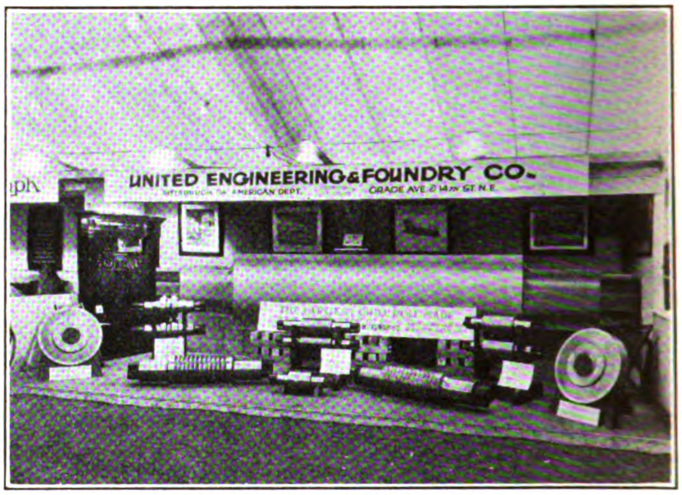
The total equipment of Steinbart pressure burners and Huessener combustion control disposed of during the last few years exceeds $1,000,000. Among recent installations are the following:

Donner Steel Company, Buffalo, N. Y., 6 boilers; Central Furnace Company, Massillon, Ohio, 5 boilers, 4 stoves; Carnegie Steel Company, New Castle, Pa., 6 boilers; Illinois Steel Company, Gary, Ind., 8 boilers; Bourne Fuller Company, Cleveland, Ohio, 5 boilers; By-Products Coke Corporation, Chicago, Ill., 4 stoves; Mystic Iron Works, Boston, Mass., 3 stoves, 3 boilers; Trumbull Steel Company, Warren, Ohio, 3 open hearth furnaces; Donner Steel Company, Buffalo, N. Y., 1 open hearth furnace; Otis Steel Company, Cleveland, Ohio, 1 open hearth furnace; Bethlehem Steel Company, Johnstown, Pa., 5 billet furnaces; Bethlehem Steel Company, Lackawanna, N. Y., 2 billet furnaces; Frodingham Iron & Steel Company, Consett, England, 2 stoves, 1 soaking pit.

A new branch office under the name of the International Heat Economy Bureau, Ltd., at the Brook House, Walbrook, London, England, which is in charge of Mr. John Miles, who was formerly connected with the Freyn & Brassert Company, Chicago, Ill.

United Engineering & Foundry Company's Exhibit Draws Attention

The United Engineering & Foundry Company, of Pittsburgh, Pa., through their American Department, had a most effective booth at the Exposition of Progress held in Canton, Ohio, recently.



The exposition was held under the auspices of the Canton Chamber of Commerce and attracted about 60,000 persons, who viewed with interest the booths of 190 exhibitors. There were many out of town spectators, as was evidenced by those who had charge of the foundry company's booth, all of whom commented upon the attractiveness with which the booth abounded, and the courtesy shown in explaining the various mill operations where rolls were used.

An exact size form of the largest chilled roll ever cast with one of the smallest hung above it formed the background, while grooved rolls for rounds, square, flats, etc., and cross sections of sheet mill rolls were displayed on the stage.

The case to the left contained over 200 rolled steel sections of various design, while upon the walls are shown photographs of various mills erected by the company.

TRADE NOTES AND PUBLICATIONS

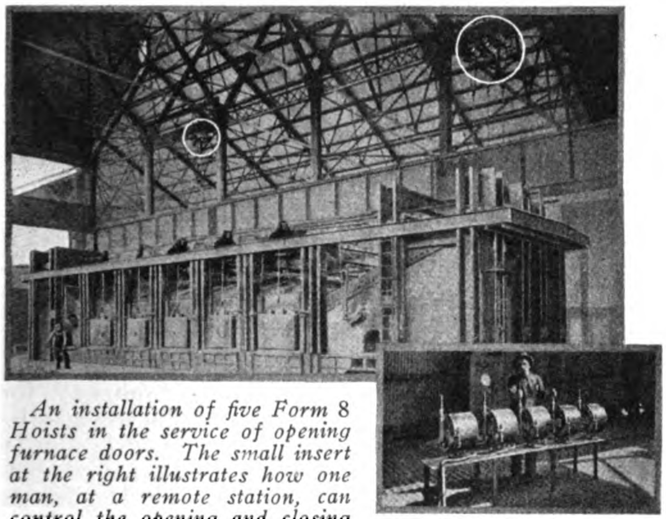
Electric Hoists for Steel Mills

If there is anything in and about a steel mill which isn't being handled or conveyed by a Shepard electric hoist, the new illustrated book of "uses" just issued by the Mountain Falls organization fails to list it.

A glance through these 42 pages of photographic reproduction is a complete course in material handling.

There are thousands of Shepard units installed in iron and steel mills, many of which were among the earliest electric hoists made by the company. They put lifting and load-moving on an economical basis and are dependable aids toward increasing production by minimizing the time required for necessary handling operations.

All Shepard cranes, hoists, winches and similar equipment are basically the same in design. They have the Shepard "balanced" drive, which consists of a double train of machine cut spur gears, driving at two points diametrically opposite, thus dividing the work among double the number of gear teeth. The stresses are, therefore, perfectly balanced and there is no pressure imposed upon the shaft bearings. Gearing is enclosed in tight metal housings and operates in baths of oil, which provide thorough, automatic lubrication. This "balanced drive" when enclosed and running in oil, naturally, is very efficient, durable and reliable to an extent not even approximated by any other construction.



An installation of five Form 8 Hoists in the service of opening furnace doors. The small insert at the right illustrates how one man, at a remote station, can control the opening and closing of each door.

Two types of control are obtainable in most Shepard equipment. Variable speed, which affords eight to 13 running speeds, according to the size of the motor, obtainable successively at evenly spaced intervals of the movement of the controller handle. Single speed allows no range of speed, and its only function is to start, stop and reverse the motor. The single speed control serves many general purposes; the variable speed control is recommended for precise lifting and lowering.

For easy reference, they have indexed the types of Shepard equipment and the various installation views shown in this book. The applications illustrated are by no means complete, but will serve to give one an idea of the extensive use of this equipment in the iron and steel industry.

Standards in the Pump Industry

The third edition of "Standards of The Hydraulic Society" has just been issued. It contains not only the information embraced in the earlier editions, but also much new and valuable data, such as a standard classification of pumps; standard nomenclature and definitions pertaining to the industry; standard dimensions for cast iron flanges and cast iron flanged reducers for 125 lb. and 250 lb. steam pressures as adopted by the A. S. M. E., and a very complete list of chemicals and other special liquids, specifying the materials recommended in the construction of pumps for handling these special liquids.

Copies of the booklet may be obtained from any pump manufacturer who is a member of the Hydraulic Society, or upon application to C. H. Rohrbach, Secretary, 90 West Street, New York.

Handbook on Superheated Steam

"Superheat Engineering Data." A handbook on the generation and use of superheated steam. Sixth edition revised. (Superseding Data Book for Engineers.) The Superheater Company, New York and Chicago, 1925. Bound in Keratol, 4½x7 in., 208 pages, 85 illustrations and diagrams, 69 tables. Price $1.00.

This handbook contains condensed data for steam power plant engineers and operators. A feature of the book is the index consisting of 16 pages, assuring ready reference. Superheated steam, its advantages over saturated steam, and the proper design and performance of superheaters, are briefly discussed. It illustrates superheater arrangements in practically all stationary, marine and locomotive type boilers commonly made in America. Waste heat, portable and separately fired superheaters are also shown. Brief comparative data is given as to sizes, tube sizes, arrangement of tubes, etc., for the stationary water tube boilers illustrated. The steam tables cover pressures from below atmospheric to 600 lb., absolute, and include properties of superheated steam from 50 to 300 deg. F. superheat.

The section on piping includes information for figuring piping for handling water, saturated and superheated steam, and velocity and pressure drop of water and steam flowing through piping. In this section is included also the proposed American standards for high pressures. Superheat Engineering Data also contains engineering data on coal and oil fired boilers, which include tables of heat values for gaseous, liquid and solid fuels. Other miscellaneous data include complete conversion tables and data on bolts and screw threads, with the recent work of the American Engineering Standards Committee.

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South Works Breaks Record—96,800 Tons of Steel in Month

Such was the extent of our production during the month just closed. We exceeded our fondest hopes and expectations in setting up this new figure of steel production. It is rather astonishing but nevertheless true. We started out hoping to top the old record of 90,600 tons. The majority were indeed sceptical but some of our members exercised a bit of foresight and said we could do better. They had confidence in our organization and it was well-warranted.

This record figure of 96,800 tons which is 6,200 tons above the old record will, no doubt, stand for a time.—South Works Review.

W. Allan Taylor has been appointed supervisor of the Pacific Coast offices of the Wheeling Steel Corporation, with headquarters in the Rialto Building, San Francisco, Calif. He has been with the La Belle Iron and Steel Company and the Wheeling coroporation since 1911. Lyman T. Banks, northwestern manager for these companies since 1919, will continue to cover Washington, Oregon and the Northwest as before.

Frank Miller, head of the coke department and J. P. Dovel, general manager of blast furnaces of the Sloss-Sheffield Steel and Iron Company, Birmingham, Ala., have been made vice presidents of the company, according to announcement recently made. Both have been with the company for a long while.

The Hudson Valley Coke and Products Corporation, Troy, N. Y., has appointed S. O. Hobart manager. The plant when completed will consist of a battery of 55 by-product coke ovens and a bast furnace. Mr. Hobard, who recently resigned from the superintendency of the Warwick furnaces, Pottstown, Pa., operated by the Eastern Steel Company, had been connected with the latter company for 25 years.

Arthur O. Baer, general superintendent Iroquois plant, Youngstown Sheet & Tube Company, South Chicago, Ill., and superintendent of blast furnaces, Indiana Harbor, Ind., works, has resigned after 27 years in the iron industry.

John H. Wilson, formerly with the United Alloy Steel Company, Chicago, has been appointed mill superintendent of the Pacific Coast Steel Company, South San Francisco, to succeed the late Charles R. Hughes. Mr. Wilson is expected to assume charge of the Pacific Coast plant about August 1.

The A. M. Byers Company, manufacturers of the well known "Red Band" wrought iron pipe, have arranged with Hickman, Williams & Company for the disposal of any surplus iron produced at the Girard blast furnace.

OBITUARY

Klaus Sollie, chief engineer of the Youngstown Sheet & Tube Company, died April 19th, 1925, at the Youngstown City Hospital, of peritonitis.

Mr. Sollie was born at Trondhjems, Norway, August 30, 1889. He attended the local schools, graduating from the Trondhjems Technical College in 1909. In September of that year he came to America and located in the Engineering Department of the Allis-Chalmers Company, Milwaukee, Wisconsin. In 1910 he became associated with the engineering department of the Sargent-Lundy Company of Chicago, Illinois. In 1911 he went to the Otis Steel Company of Cleveland, Ohio. In 1914 Mr. Lief Lee, who was at that time chief engineer of the Youngstown Sheet and Tube Company, acquired Mr. Sollie's services and he was made engineer in charge of mines, and afterwards assistant chief engineer, which position he held until Mr. Lee severed his connection with the Youngstown Sheet & Tube Company in 1921. Mr. Sollie was then appointed chief engineer, and held this position to the time of his death.

Some Pointers on By-Product Coke Oven Operations

Offers Scholarship in Gas Engineering

Two scholarships in gas engineering in Johns Hopkins University have been offered by the Consolidated Gas Electric Light & Power Company, according to an announcement. The scholarships, which are worth $350 a year each, are open to residents of Baltimore and vicinity who can meet the University requirements for entrance. Applicants may qualify for admission by graduation from an approved high school or by examination to be held September 14 to 17, 1925.

The appointments to these scholarships will be for one scholastic year. The holders will be eligible for reappointment from year to year if they conform in character, industry and ability with the standards and requirements of the University.

The course in Gas Engineering at Johns Hopkins University was originally established by the Baltimore company in co-operation with the Southern Gas Association. The Gas By-Products Laboratory of the University is probably the only complete plant of its kind in America and is available for research work for students desiring to follow gas engineering. The Department of Gas Engineering makes an especial effort to maintain intimate contact with the various gas and fuel industries in and about Baltimore, which has long been a center for advanced developments in this field. Co-operative arrangements permit the use of the facilities of several of these industries for instruction and research.

One of the newer developments that is engaging the attention of gas engineers throughout the country is the Cottrell electrical precipitation process for the extraction of tar from gases. The Tampa Gas Company, which is always in the van in acquiring the latest apparatus for its plant, has just contracted with the U. G. I. Contracting Company of Philadelphia for the installation of one of these Cottrell precipitators and will very shortly have it installed and in operation. By its use the Tampa company expects to greatly increase the efficiency of tar extraction and to decrease the load on the purifiers. "Cottrell" has an efficiency of 95 per cent and therefore great things are expected from its operation.

Now that the U. G. I. vertical retort plant is in successful operation the Syracuse (N. Y.) Lighting Company has placed order with the U. G. I. Contracting Company of Philadelphia for the foundations and other work preliminary to the erection of a second unit of U. G. I. vertical retorts. This unit will consist of nine benches.

Luzerne County Gas and Electric Corporation of Hazleton, Pa., contemplates improvements to its plant and has awarded contract to the U. G. I. Contracting Company of Philadelphia for the installation of new turbine blower equipment and welded steel piping; also the installation of an overhead welded steel foul main system. These improvements will be of considerable help in smoothing out the operation of the Hazleton plant.

Chrisman Down-Run Process

The down-run process developed under the direction of Mr. C. S. Chrisman, of the U. G. I. Contracting Company, and applied to a carburetted water gas set, has been described in a paper presented to the Pennsylvania Gas Association by Mr. L. W. Seltzer, the engineer to the Reading, Pa., Consumers' Gas Company. The process is one by which all the gas made on the down run is taken from the bottom of the generator and led to some point beyond the superheater but ahead of the wash box, thus making the down-run gases by-pass the carburettor and superheater. The idea is based on the fact that the gases made on the down run leave the generator at a very much lower temperature than either the blast or the uprun gases, and that this temperature is far below that required in the carburettor and superheater for efficient oil results. These comparatively cool gases by-passing the carburettor and superheater prevent the unnecessary abstraction of heat from the plant, and the correct temperature for efficient oil fixing can be maintained with a decreased fuel consumption. For the purpose of properly carburetting the gas, it becomes necessary, with this process, to use oil during the up run only. The gas company at Reading has used this method of gas making, with a decrease of from two to three pounds. per 1,000 cu. ft. in generator fuel, and a considerable increase in the capacity of the set.

Koppers Company to Build Coal Gas Plant

The Rochester Gas & Electric Corporation, Rochester, N. Y., has placed a contract with the Koppers Company covering the design and erection of a coal gas plant to have a capacity of approximately 5,000,000 cubic feet of coal gas per day. The plant will consist of 37 Koppers Company's Becker type by-product gas ovens and four Koppers type gas producers.

Reproduces Order 100 Years Old

The Lukens Steel Company, of Coatesville, Pa., reproduced in a recent advertisement in an industrial paper an order which was received by Dr. Charles Lukens, who started the business, in 1825.

"In Quaker terms," comments the advertiser, "the buyers doubted the practicablity of making a 2 foot, 10-inch head from one plate. They specified plates were to be free of 'buckles and bilges.'

"Aside from its historical interest, this letter furnishes interesting evidence of the progress of plate manufacture during the past century."

NEWS OF THE PLANTS

The Gulf States Steel Company, Birmingham, Ala., has completed plans and will begin construction of a new bar mill at its plant at Gadsden, Ala., consisting of structures 80x700 ft. and 150x700 ft., reported to cost in excess of $500,000, with equipment. The installation will provide for a maximum capacity of close to 10,000 tons of round and flat bars per month. The machinery will be electrically operated and additional power facilities will be arranged at the plant to carry the increased load.

The Vulcan Mold & Iron Company, Latrobe, Pa., has leased the local plant formerly occupied by the Peerless Foundry Company, and will remodel and improve for a new branch mill. Additional equipment will be installed, including an electrically operated furnace and accessory apparatus. The new plant will be used for the production of iron molds as well as kindred iron products. The estimated cost of the expansion has not been announced.

The Hudson Valley Coke & Products Corporation, Troy, N. Y., has foundations laid for its proposed new blast furnace and plans for superstructure work at an early date, or as soon as steel, now being fabricated, is available. The new unit is slated to be completed and ready for service in the fall, and every effort will be made to carry out this schedule. The furnace will have a rating of about 450 tons per day, and is estimated to produce on a basis of close to 150,000 tons of pig iron per annum. The plant will be supplemented by a battery of 55 coke ovens, on which work is now under way; these will have a rated output of 365,000 tons of material a year, about one-half of which will be used at the blast furnace and the remainder placed on the market. The by-products ovens are the design of the Foundation Oven Company, a subsidiary of the Foundation Company, New York, which is financially interested in the enterprise. The by-products plant will produce coal tar in an estimated amount of 5,300,000 gallons per year; ammonia sulphate, 14,000,000 pounds a year; benzol, 17,500,000 gallons per year, and other affiliated products. The layout has been designed to allow for the construction of a second blast furnace of approximately like size at a later date, while ultimately there will be three batteries of by-product coke ovens of the 55-unit each type. The company was formed a number of months ago by officials of the Burden Iron Company, and the new plant adjoins this works, the furnace occupying the same site as the former unit of the Burden company, which was dismantled a few months ago. The entire initial plant will represent an investment in excess of $5,000,000. James A. Burden is chairman of the board of directors, and Henry Oliver of the Oliver & Snyder Company, also interested in the company, will act as president.

The Jones & Laughlin Steel Corporation, Pittsburgh, Pa., has preliminary work in progress for the improvement of its property at Hammond, Ind., on which a new steel plant ultimately will be located. The present development consists of filling in the land with slag and cinders, and necessary grading and property betterment for the initial unit. Plans for a private sewerage system from the plant have been approved by the city officials, and permits have also been secured for a private water supply from Lake Michigan. It is said that plans are in preparation for the proposed plant and that actual work on the buildings will be started in the near future. The complete project is estimated to cost in excess of $10,000,000.

The Beckwith Iron Works, Inc., Chicago, Ill., has plans under way for the first unit of a new plant at site selected at 9100 South State Street. It will be one-story, 85x200 ft., and will be supplemented by other structures for steel and iron working at a later date. A general contract for the first building has been awarded to Olson & Berg, Rhodes Avenue, Chicago. Frank J. Saridakis, 68 West Washington Street, is architect.

The Youngstown Sheet & Tube Company, Youngstown, Ohio, has decided to dismantle the No. 1 blast furnace at the former Iroquois Works of the Steel & Tube Company of America, acquired by the Youngstown company close to two years ago, and has commenced razing. The unit was built in 1891 and was operated last by the Miami Metals Company for ferroalloy production; it has been idle for several years. The No. 2 stack at the Iroquois plant is also idle at the present time, but will be held as a reserve unit by the present owner; as soon as conditions in the pig iron market necessitate, the furnace will be improved and blown in; a number of necessary repairs and alterations will have to be made. The three other stacks at the plant, of which two are now in service, will be retained by the company.

The Aetna Iron & Steel Company, 520 East Eighth Street, Jacksonville, Fla., manufacturer of structural steel and other general iron and steel products, has acquired property fronting on the tracks of the Seaboard Air Line Railroad, between Market and Hubbard Streets, as a site for a new plant, estimated to cost close to $100,000, with equipment. The initial structure will be 90x200 ft., supplemented with smaller buildings. The present plant of the company will be removed to the new location and considerable additional equipment installed. This existing works will be remodeled for a general warehouse and distributing branch. J. M. Burrell is president.

Consumers Power Company, Pontiac, Mich., has enlisted in the army of automatic control users and has placed orders with the U. G. I. Contracting Company of Philadelphia for a model "B" U. G. I. automatic control to be installed at its Pontiac plant. The U. G. I. automatic has demonstrated its value in water gas apparatus operation and the Pontiac management are expecting great things from it.

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The Blast Furnace and Steel Plant

Member of the Audit
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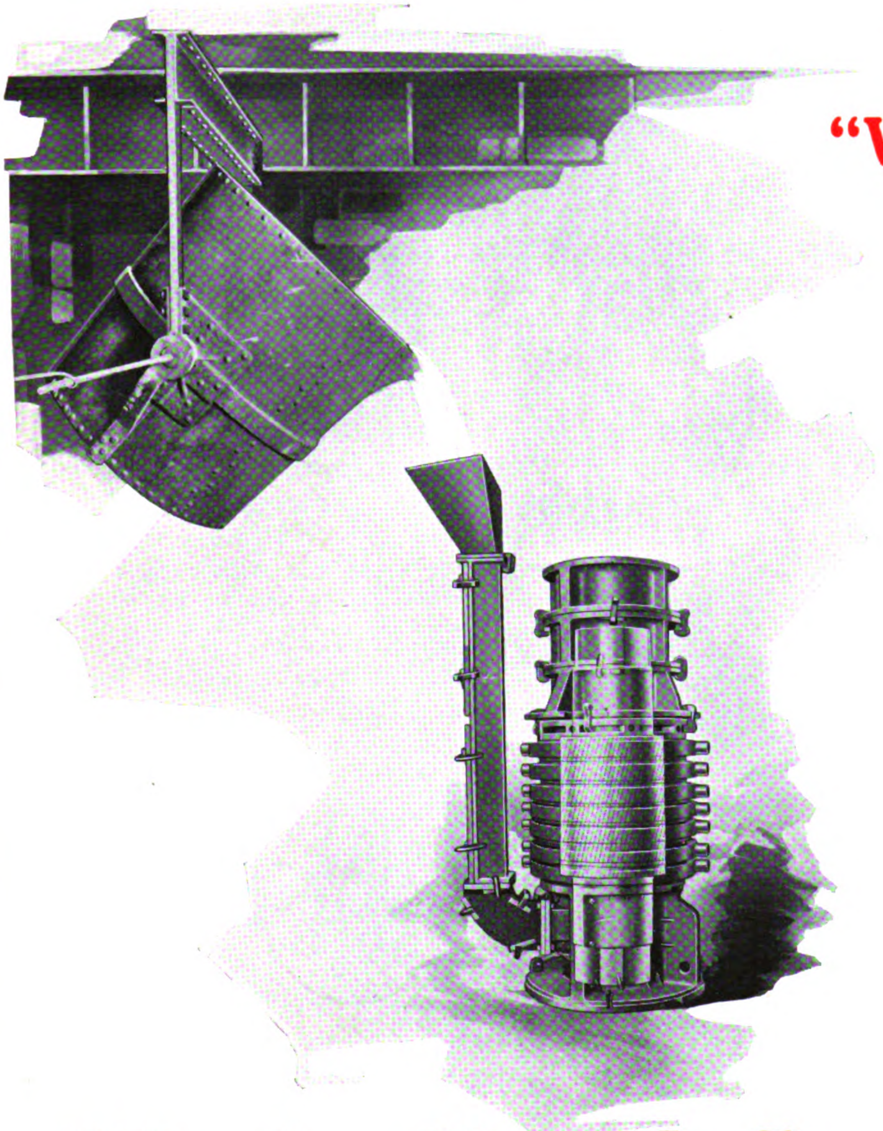
PITTSBURGH, PA., JULY, 1925

Entered as second class mail matter at Pittsburgh, Pa., under the act of Congress, March 3, 1879.



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